W. H. Seward

MOSES H. PERLEY

As a memento of the earlier years of this Society a vignette of the late Moses H. Perley is inserted in this Bulletin. Mr. Perley was one of its founders, and for several years the first Vice-President. He took an active interest in its welfare, read papers at its meetings, and gave several contributions to its museum,—but an untimely death deprived the Society of his valuable services, not many years after its institution.

Mr. Perley wrote reports on the Fisheries of New Brunswick, addressed to the legislature of New Brunswick, 1849–51, which for many years remained the authority for information on this important subject, and is quoted and referred to in Dr. Cox's article on the Fishes of New Brunswick issued in this Bulletin.

Besides his reports on the fisheries, Mr. Perley also wrote a very useful little "Hand-Book of Information for Emigrants to New Brunswick," which contained an account of the climate, forests, fisheries, geology and mineral resources, topography, and other useful information. This was published in London (1857) in aid of immigration, for which he was agent, or officer, at that time.

Known as an authority on British North American fisheries, Mr. Perley was appointed British commissioner for settling the boundary along the Atlantic coast of British America within which only British subjects have the right to fish. It was while engaged on the work of this commission that Mr. Perley died suddenly at Forteau, on the coast of Labrador, in August, 1862.

Mr. Perley was a native of New Brunswick, born at Maugerville, 31st December, 1804. He was educated at St. John, N. B., called to the bar in 1830, and practiced law for some years in that city. Of his family only one, Henry F. Perley, C. E., of Ottawa, now survives.

BULLETIN

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OF

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BULLETIN

OF THE

NATURAL HISTORY SOCIETY

ERRATA.

Page	36,	line	21,	for	"re-echoing,"	read, re-echoing.
"	37	"	20,	"	"*Leuciseus*,"	" *Leuciscus.*
"	38	"	4,	"	"*anguillaris*,"	" *anguillaris.*
"	38	"	25,	"	"*Anguilla*,"	" *Anguilla.*
"	50	"	16,	"	"Uranidea,"	" Uranideæ.
"	51	"	15,	"	"*quadrilateriads*,"	" *quadrilateralis.*
"	53	"	14,	"	"*longirostus*,"	" *longirostris.*
"	64	"	4,	"	**"oxyrinchus,"**	" **oxyrhynchus.**
"	71	"	5,	"	"head-quarters"	" head-waters.
"	94	"	12,	"	"this new knowledge," read, new knowledge of this kind.	
"	88	"	17,	"	"archology," read, archæology.	

*In the first paper (p. 4, footnote) I said this term had not been before used, so far as I was aware. The editors of the *Botanical Gazette* (XX. p. 38) have called my attention to the fact that the word occurs in the Century Dictionary, and Mr. F. L. Sargent of Cambridge reminds me that it is used by Lubbock in the title of a paper of his upon Seeds and Seedlings, published in the Trans. Linn. Society for 1886. It would have been strange if so fitting a word had not before found use.

BULLETIN
OF THE
NATURAL HISTORY SOCIETY
OF
NEW BRUNSWICK.

AN OUTLINE OF PHYTOBIOLOGY.

With Special Reference to the Study of its Problems by Local Botanists and Suggestions for a Biological Survey of Acadian Plants.

BY W. F. GANONG, PH. D.

Read June 4, 1895.

SECOND PAPER.

ADAPTATIONS OF PLANTS TO LOCOMOTION.

In the first paper of this series, Phytobiology* was defined, its relations to other departments of botany were explained and divisions were proposed for its treatment. In taking up these divisions it is not needful to hold to the order there given; and I have decided to treat first the one which I think will prove of the greatest use and interest to our botanists. This is the adaptations of plants to locomotion. Its relation to other topics of the series is

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shown in the following synopsis, which, as already emphasized, outlines a convenient rather than a logical treatment of the entire subject.

Introduction and Classification. *Published in Bulletin No. XII.*
A. Adaptations of Plants to Inorganic Nature: *to be prepared.*
B. Adaptations of Plants to other Organic Beings: *to be prepared.*
C. Adaptations of Plants to Reproduction: *in preparation.*
D. Adaptations of Plants to Locomotion: *the present paper.*
E. The Biological Groups of Plants: *in preparation.*
F. The Climatic Groups of Plants: *to be prepared.*
G. A Summary of the Biological Characteristics of the Vegetation of Acadia: *to be prepared.**

I. The General Subject.

There are five great primal necessities common to all living beings: nutrition, growth, protection, locomotion, reproduction. Of these, locomotion, our present subject, is not less important than the others, while it exceeds them all in the elaboration of adaptations to bring the plant into relation with its environment. Viewing locomotion in a broad way, we find that it must be provided for in both animals and plants for the following reasons:

1. To prevent overcrowding, so as to allow each individual enough space for its development.

2. To effect the union of the sexes.

* This is the original outline proposed in the first paper, to which, however, it is not necessary closely to adhere. A more logical arrangement, and one which I shall probably adopt, is as follows: Adaptations of Plants to *A. Nutrition; B. Growth; C. Protection; D. Locomotion; E. Reproduction. F. Biological Groups; G. History and Distribution; H. Philosophical Summary; I. Summary of Biological Characteristics of Acadian Flora.*

I may here also emphasize such distinction as exists between Physiology and Biology, though they merge together at many points. Physiology has to do with the chemistry and physics of the operations, chiefly internal, of living beings, while Biology treats of their adaptations to the external world.

In addition it secures to them the following advantages, and these are of vast importance in the struggle for existence.

3. To give the new individuals opportunity to develop under environment somewhat different from that of the parents, thus promoting vigor and variability, the two qualities upon which progressive development in evolution depends.

4. To mix individuals derived from different environments so that cross-fertilization may occur between plants of different stock, thus promoting in the offspring the advantageous vigor and variability.

5. To allow a race to move to new localities as it exhausts certain essentials in the old.

For the animal world should be added to these, to escape from enemies, a condition which in plants must be otherwise worked out.

Among animals, all of these advantages are secured to them by the power of independent movement which they nearly all possess; but among plants, which lack this power, the same end must be attained in a totally different way. One of the most fundamental differences between animals and plants consists in this, that plants being nourished by inorganic materials which are brought to them by the movements of the atmosphere, or of water in the soil, have not needed to move for the greatest of all necessities, that of food; their cells have accordingly built up the firm non-contractile cellulose and its derivatives, a supporting skeleton capable of great size and strength, but not of motion; while animals, living upon other organized beings, which they must go in search or pursuit of, have formed a contractile substance, muscular fibre, and the presence of this gives a muscular system and the possibility of locomotion to even the largest animals. Yet that plants do in some way secure locomotion

is very clear. One has only to recall the rapid spread and great range of weeds, or the world-wide distribution of many water-plants. Indeed, taken as a whole, it is probable that the aggregate locomotive accomplishments of plants are fully equal to those of animals, even though they are less rapid, less striking, less well-known. How then, it is now our task to inquire, does it come to pass that plants, themselves incapable of independent locomotion, yet so perfectly secure it? The answer is in essence this: It is secured to them *by the separation of small parts of their substance capable of reproduction, and the adjustment on these of structures adapted to utilize the various locomotive forces of nature.* The end is thus as certainly attained as among animals; there is but a difference in the method. Instead of the entire organisms moving, small reproductive parts move; instead of by internal powers it is by utilization of external agencies which can move.

Of the five needs for locomotion above-mentioned, the third, fourth and fifth can be secured along with the first, and indeed in the animal world all five are ensured by the power of independent movement: but among the higher plants, the first and second require distinct methods. In the first case, that of simple scattering to prevent overcrowding, the problem is simply to remove to a considerable distance, and preferably to favorable situations, reproductive parts of a plant; in the second case, that of effecting union of the sexes, *i. e.*, union of pollen and ovule, the problem is more difficult, for not only must one of the uniting elements be removed to a distance, but it is to be deposited in a special position, *i. e.*, the male is not simply to be carried away from its producing structure, the anther, but it is to be deposited on a special part of the female organ, the stigma, and the problem is made

the more difficult by the fact that cross-fertilization being absolutely more advantageous than self-fertilization in nature in the struggle for existence, it has to be provided that the carrying of the pollen shall be to the stigma of another plant. Hence come the adaptations to cross-fertilization, resulting in the formation of the flower, with its colors, odor, nectar and varied forms, the whole affording us the most splendid example of adaptation to be found in the vegetable kingdom. This division of locomotion is, however, so large and important that although it belongs logically in the present paper it must receive separate treatment, and it will be considered in a future paper of this series along with "adaptations to reproduction;" at present we devote our attention to locomotion of plants as scattering them through space.

Let us understand clearly the mechanical problem involved. A piece of matter endowed with life, and having size and weight, must be moved through a considerable space in such a manner as not to injure it. Only a very limited movement can be effected by the plant itself, so that in the vast majority of instances the movement must be effected by outside agencies. How, then, can the plant effect movement, and what are the forces in nature outside of the organism capable of moving ponderable matter?

The former can occur through

I. Independent animal-like movement.
II. Extension away of parts by growth.
III. Locomotion by movements of ripening tissues.

The latter are

IV. Currents of air.
V. Currents of water.
VI. Movement of animals.
VII. Gravitation.

Of these, gravitation is of little importance since it can only effect movement downwards and not laterally. As to the others, aside from the first which uses simply the contractile power of protoplasm, some mechanical arrangements must be provided so that the part may be brought into contact with the moving power, and be moved by it. This is in brief accomplished by the formation of new individuals at the ends of runners, etc., in the second case, by the drying or ripening of tissues under tension and their sudden release in the third, by formation of wings or plumes in the fourth, and of floats in the fifth, and finally by the development of hooks or sticky coats, or of edible fruits enclosing seeds protected from digestion, in the sixth: of course all kinds of combinations and gradations between these methods occur. The principles of these arrangements we must discuss in some detail.

We must consider next what parts of plants can best be locomoted. Excepting in the first and second, where growth and locomotion go on together, it is necessary that the part shall be capable of reproducing the organism that it can hold its life for a time in suspension, that it shall carry nourishment to give it a start in its growth, and that preferably it shall be small and light. In some cases, especially in the lowest cryptogamic water plants, these qualities reside in the entire organism, and these move as a whole, but in the higher land plants there have been developed special structures which combine these qualities; these are in some cases, buds, in others spores, and most important of all, seeds. Buds usually have the disadvantage of not being able long to retain vitality after separation from the parent plant, but seeds can retain their life for much longer periods and during long transportation, and it is in them that we find by far the most perfect arrangements for locomotion. Indeed the

seed is what it is mechanically, chiefly because it is the locomotive stage of the plant.

The seed is, in origin, a fertilized ovule. The flower is itself a structure for securing locomotion, the locomotion of the male to the female and all of its parts and colors and odors, etc., are adaptations to this end. Immediately after the act of fertilization all of the accessory parts, calyx, corolla, stamens, style and stigma, become useless, and they either wither and drop off, or else they may be retained and made of use to help form the various structures, which the seed needs in order to take advantage of moving agencies; thus any of them may form wings, plumes, floats, hooks, pulps, etc. In all such cases the seed itself has no disseminating structures of its own — those of the fruit are sufficient. This occurs commonly in few or single-seeded fruits, which are indehiscent and where the entire structure ripens or is carried off. But in fruits containing many seeds, the fruit remains on the plant until all seeds are ripe, and each seed has some arrangement for locomotion by itself.

From a biological point of view it does not matter in the least from what part the disseminating structures are developed, but from the morphological side it is very important to trace the exact structural origin of each peculiarity. It is soon apparent that the same biological end may be attained in the most diverse morphological ways; a wing may be either bract, calyx, wall of ovary, or outgrowth of the seed coat; the pulp of a fruit may be bract, receptacle, calyx, ovary, placenta, hairs or seed-coat, and so on. Any available structure whatever may be expected to be utilized for the formation of a useful feature. What it is which determines what particular morphological part shall be employed in any given case, is usually unknown, but there can be no doubt

that in general it is determined by the fundamental principle of least resistance — the most available or the most easily modified structure is led by the adaptive forces along the easiest lines, and the result is the structure as we have it.

It is of course necessary in the study of locomotion as elsewhere in phytobiology, to distinguish that which has been adapted from that which is incidental. All gradations between these occur. Without doubt in very many cases the adapted has originated in the incidental. Thus the presence of a wing on a seed is a case of gradual adaptation to wind-locomotion, and the principle of natural selection explains very well how adaptation may have been perfected. On the other hand the wide locomotion which willows secure by the floating of their brittle and wind-broken twigs is incidental, though it is easy to understand that if it were worth while this mode of locomotion could be improved and perfected, Examples of structure just on the boundaries of the adapted and incidental are found in some of the modes of vegetative locomotion presently to be mentioned.

As in the case of many other natural phenomena, the facts of locomotion have long been known, but it is only in this century that the philosophical significance of the facts has been understood. That seeds are scattered by wind and animals is plain to observation; but to know that plants derive advantage from this, and that the advantage in the keen struggle for life to which they are exposed may explain the perfecting and even the origin of the adaptations to secure the locomotion, this is knowledge which has been gained slowly and has been made possible only by the light thrown upon all organic processes by the principle of evolution.

The classical work on locomotion of plants is Friederich Hildebrand's "Die Verbreitungsmittel der Pflanzen," (The Dissemination-methods of Plants), published in Leipzig, in 1873. This work sums up the subject most admirably and is characterized by philosophical treatment, richness in facts and judicious selection in illustration. No work has yet superseded it, and all students since its appearance have based their studies upon it. I have myself made free use of it in the preparation of this paper. Darwin has much to say on this subject in the "Origin of Species." Since then Hildebrand, Huth, MacLeod, and very many others have worked on the subject. MacLeod has published a most useful bibliography of publications on dissemination from 1873 to 1890 (in Botanish Jaarboek, Ghent, 1891.) Finally, Kerner, in his "Pflanzenleben," (English translation by Oliver,) has given us a most valuable though popular discussion, richly illustrated, and Lubbock presents a good summary in his "Flowers, Fruits and Leaves." The present paper is designed not to describe the facts already so well set forth in these works, but is an attempt to reduce our knowledge of the subject to definite principles which will make more easy an objective knowledge of the subject and guide our local botanists in further studies into the subject.

II. Principles of the Modes of Locomotion of Plants.

I. Independent Animal-Like Movement.

Since plants lack altogether muscular fibre, it is only possible for independent automatic locomotion to occur where the contractile power of the protoplasm itself can be utilized. This occurs only in unicellular or very few-celled organisms, *i. e.*, only in the lowest and smallest plants. Many of the lower algæ produce spores, (called

zoospores) which can swim freely through the water by means of cilia or flagellæ, precisely as animals of an equivalent grade do. The Diatoms move by use of protoplasmic filaments, and some filamentous algæ, the Oscillariæ, by vibrating movements of their rod-like structure. Among land plants, some of the slime-moulds, or Myxomycetes, can creep over damp surfaces exactly as the animal amœba does, *i. e.*, by continually causing its very plastic substance to flow in a constant direction. No higher land plants whatever have the power of independent locomotion.

II. Extension Away of Parts by Growth.

In the higher plants, a branching root and stem system prevails, each part of which grows only at or near its tip. By sending out these growing parts laterally and allowing them at a greater or less distance to turn upward and grow into an erect plant, or to send off an erect plant by branching, an effective and rapid though not extensive locomotion can be brought about. The connecting part may subsequently die, leaving them independent. There are several ways in which lateral growing parts may act.

1. Horizontal underground roots and rhizomes, more or less long and slender, may send up new plants (called "suckers") from adventitious and axillary buds respectively. Examples of the former are Blackberry, *Asclepias Cornuti*, etc., and of the latter, *Triticum repens*, *Achillæa millefolium*, and many others. The same method occurs abundantly in water plants. It incidentally brings about the formation of turf, and makes some plants very difficult to exterminate, and hence they become "weeds."

2. Offsets and runners above ground form new plants at their tips. The Houseleeks *(Sedum)*, *Lobelia cardinalis*, show the former, and the Strawberry, *Potentilla anserina*, etc., the latter method.

3. Slender stems or branches bend over and take root and produce a new plant at their tips forming "stolons;" such are some species of Rubus.

4. Plants in which the main stem creeps horizontally either above or below ground and in which the old parts die behind as the new advance, attain locomotion by the very act of growth. Ferns and Solomon's Seal are examples. Such plants may branch and after a time by the death of the old connecting parts may give rise to several independent individuals. In the tropics there are epiphytic plants which creep along the stems of trees and have this same habit, such as *Pothos*.

5. Bulbs may be drawn away from their producing plants by the shortening of lateral roots. Many bulb plants which form small side bulbs, send out from them, horizontally, slender roots. Later, the connection of bulb with the old plant is severed, the roots shorten and draw away bulb from plant. *Ornithogalum nutans* and *Tulipa sylvestris* are examples.

6. An inclined stem may develop aerial roots called "stilt roots," by which it is nourished and supported several feet from the ground; in time the old stem and roots die behind and the plant continuing to grow and to produce new roots, the plant thus secures movement from place to place. None of our plants do this but it occurs in many of those of the tropics. A modification of this habit, in that the old parts continue to grow, there is profuse branching, and the roots thicken up to stems, gives us the habit of the banyan.

In addition to the formation of new plants at the ends of laterally extended parts, many forms of separable buds, bulblets, branches, etc., are formed directly upon the plant, but these all are adapted to being scattered by some of the moving agencies, wind, water, etc., and they will be considered under those topics.

III. Locomotion by Movements of Ripening Tissues.

Although the skeleton built up by plants out of cellulose and its derivatives is not contractile, it nevertheless is capable of producing locomotive movement if ripened in special ways. By this means either slow, creeping movements or very rapid projection may result, though the resulting locomotion can never be great. It is clear that for projection, seeds, not buds, nor even very light spores are adapted, and the most efficient seeds for projection are nearly or quite spherical, smooth, hard and rather heavy. The various modes are as follows:

1. Cell walls may become strongly hygroscopic, swelling and shrinking and altering shape as moisture is absorbed and given up, just as a board warps, and in small pieces the movement may be rapid. Sometimes slender hyroscopic arms are attached to spores and move them from the capsule or even farther, as in the spores of *Equisetum*. In *Vanda teres*, a tropical orchid, hygroscopic hairs force out the seeds to be carried off by the wind. There are even a few seeds and fruits which are pushed along the ground by the hygroscopic twistings of some of their hairs, certain hooks which point backward allowing only of a forward motion. Such are some species of *Trifolium*. In *Avena sterilis*, the "living oat," this movement is very perfect and may be somewhat sudden. Related movements assist in burying seeds as will presently be considered, and in closing fruits when weather is unfavorable, and opening them when favorable.

2. Certain bands of tissue may ripen under restraint in a state of tension so that finally, and more or less connected with drying-up or hygroscopicity, when the restraint is released or overcome, the parts spring suddenly to a new position and hurl out the seeds, sometimes to a distance of many feet. This may come about by the formation of special elastic unicellular "elaters" which force out the spores from the capsule in many mosses. Or the sides of the carpels may come to press harder and

harder upon the smooth seeds between them until these are suddenly and swiftly ejected as one shoots a bean or nut from between the fingers, as in some stemmed violets. Or the styles may ripen on an elongated receptacle forming springs to hurl away ovary or seeds as in the genus *Geranium*. Or the carpels under spiral tension burst all apart from one another as in many Euphorbiaceæ, in some cases as the castor bean, or better the West Indian "sand box," bursting with a loud report and hurling the seed many feet. Or two-valved pods may split suddenly by the independent rolling up of the two valves, as in some vetches and lupines.

3. Soft fruits may become strongly turgescent, *i. e.*, gorged with water in their inner and dry on their outer parts, until finally they explode at the weakest point and shoot out the seed. This happens in fruits with valves, in which case the latter usually suddenly curl up and throw off the seed, as in *Impatiens*, and many Cruciferæ, or the entire pulpy interior may become turgescent under a firm skin, as in some Cucurbitaceæ. In the "squirting cucumber" of the Levant, pulp and seeds are shot through the opening left where the fruit drops from the stalk, while in *Cyclanthera* it bursts along the sutures.

The power of ripening tissues to produce movement is also used to assist seeds in self-planting, and to aid locomotion by the production of tumble-weeds and to form elastic stalks, all presently to be described.

IV. Locomotion by Utilization of Air Currents.

Of all of the locomotive forces of Nature, air currents are the most universally prevalent and easily utilizable. They are of all grades, from the barely perceptible up-and-down convection currents of still warm days to great gales. To effect by them a movement from place to place, it is simply necessary to develop about the seed structures which will spread as great a surface as possible in

proportion to weight. This principle is worked out in various ways as follows:

1. Various more or less light vegetative parts capable of reproduction may be blown from a plant by strong winds: such as leaves in begonias and Bryophyllum, joints of stem as in some cactuses, rosette branches in some sedums, small bulblets in some lillies and ferns, even brittle twigs as in willows, though here doubtless the mode of locomotion is rather incidental than developed.

2. Plants or their parts develop large surfaces and are rolled by the wind along the ground. Entire plants curling their branches upward assume a ball shape, loosen their hold on the soil by rotting or breaking or pulling out of the roots and are blown along, rolling over the ground as "tumble weeds," either scattering their seeds as they roll, or more commonly coming to rest and scattering them, when rain gives proper conditions for their growth. Such plants are rare or wanting in wooded regions, but are abundant on open plains especially those with a long dry season. The "Russian thistle," now doing so much damage in the west, is a good tumble-weed, and *Plantago cretica* of Europe, and possibly the "Resurrection Plant," of the south-west is another. The classical case of the "Rose of Jericho," of Palestine, must be given up as it only rarely and accidently becomes uprooted. It is frequently the case that fruit clusters become tumble-weeds, as in some Umbelliferæ, and in some clovers where the sterile stalks of a head become feathered and this gives a surface for the wind to roll along the fertile ones. Sometimes the fruit curls up to a helix with very flat spirals, and is thus rolled along as in some species of *Medicago*, and there is perhaps an approach to this structure in the pods of the honey locusts; or the single fruit may become very large and loose in texture, or the pod very flat and thin, and be carried far from the plant by the wind and then rolled along. It is probable that some seeds, as those of the birches, are adapted to being blown along the surface of the snow.

3. By extreme minuteness a relatively large surface proportional to bulk can be attained without special appendages, for as a sphere diminishes in size its bulk diminishes relatively more rapidly than its surface. Thus very minute spores can swim in the air like dust, as do these of moulds, etc., and those of mosses, ferns, etc., can easily be blown to great distances. Amongst Phanerogams the presence of a several-celled embryo makes it difficult to reduce them to so small a size, but in certain orchids they are very minute. Plenty of plants bear tiny seeds, which, thrown from their capsules by strong wind-gusts, are by them carried considerable distances, as will be mentioned below. Sometimes as in orchids, the seeds are surrounded by a sort of loose sac containing air which makes them much lighter.

4. Seeds or fruits of trees develop wings which either act as sails or else as parachutes, causing the slow fall and hence wider lateral carrying by the wind. In all cases the centre of gravity of the seed is so adjusted that the fall is as slow as possible. In the simplest cases, the seed itself becomes very flat and thin, as in some species of Iris; in addition there may be the development of a wing around the edge. The wings may be formed from a bract as in linden, grasses, *Carpinus*; from the ovary as in elm, maple, ash; from the corolla in rare cases; from the calyx as in scabiosa; from the seed-coat as in catalpa, pines and spruces.

As noted, wings are almost confined to tree seeds, since the height of the tree gives them a good start with the winds, which would not be true in herbs or low plants.

5. Upon herbs and low growing woody plants, where the seeds need not only to be carried laterally but also raised in the air, plumes or tufts of hairs are developed. Frequently these are such that the entire mass forms a light ball, but more often the plumes are at one end, sometimes connected with the seed by a stalk, as in the dandelion, in which case the whole structure keeps an upright position and the wind may carry it for immense distances. Indeed where the plume spreads out horizontally and the seed hangs on a stalk beneath to keep the whole

balanced, even the light convection currents of a hot summer day may raise them up to considerable heights, whence they may be widely spread. These light plumes form the most efficient of all the modes of locomotion. Most weeds owe a part at least of their success to them, and the family Compositæ owes its great predominance in part to the fact that the collection of the flowers into heads and their protection by the involucre has set free the calyx to form the pappus, giving to each single seed one of the most effective of known disseminating structures.

The plume or hairs may be formed of the sterile flower stalks of a cluster, as in the "smoke bush;" from the fruit stalk as in *Typha:* from the calyx as in compositæ, from the style as in *Geum* and *Clematis*; from the wall of the ovary; from the seed-coats as in cotton and milkweeds; from the funiculus as in willows. In rare cases the fibro-vascular forms after decay of the soft tissue a light frame easily blown away.

6. The stalks of seed-pods may ripen elastically so that when gusts of wind shake the pods, the seeds are hurled out especially by the recoil. In these cases, the seeds, which are small and smooth, are early loosened in the pods and the latter open not at the bottom or along the sides but at the top, and in such a way that they form smooth grooves along which the seeds as they are hurled out are guided at such an angle that they are sent to the greatest distance. This is one of the commonest modes of locomotion among herbs, and occurs according to Hildebrand in *Scrophulariaceæ*, *Campanulaceæ*, *Papaveraceæ*, *Primulaceæ*, *Caryophyllaceæ*. It may be well seen in the common poppies. This shaking of the stalks and their sudden recoil may be brought about also by passing animals, and probably the bladdery pods of some plants as *Staphyllea*, etc., may assist this mode of locomotion by giving the wind a larger surface to work against.

The wind may also assist in locomotion by driving floating seeds over lakes or the ocean either by blowing directly against them, or by creating surface currents which carry them.

V. *Locomotion by Water Currents.*

To utilize the movement of water currents for locomotion, it is needful that the parts to be scattered shall float, and be able to resist decay for a considerable time, but finally sink to the bottom. The floating is usually effected by the development of air-holding tissue. Water currents are of three kinds: 1. Those caused by falling rain, both as it falls and as it runs along the ground; 2. Those caused by wind on non-flowing water; 3. Those of flowing water. Of these the first and second are not of much importance, and there is probably more of the incidental than of adaptation in the locomotion they effect; the third is more efficient.

The various types are as follows:

1. Seeds or fruits of wind-scattered land-plants are very light, and when accidently they fall in water, they float, and may be carried far. But they rarely reach conditions favorable to germination and hence this incidental method is of little value. It may, however, explain the reported fact that some heavy-nut trees which are migrating northward, are found upon branches of the St. John which flow from the south and not on those flowing from the north.

2. Floods may tear out root-stalks, fruits and other parts of plants and carry them to situations in which they can grow when the floods subside, but here, also, we can have no adaptation—only incidental locomotion.

3. Entire plants or their vegetative parts may be carried by currents. This occurs with many algæ. The plant may let go its hold on the bottom, float down stream and later take root again, as in *Nasturtium lacustre;* or it may float normally throughout its life as in *Lemna* and *Salvinia*, the water hyacinth of Brazil, which makes floats of its swollen leaf-stalks, and others. Detachable buds are common in water-plants, which are either lateral and protected by bracts as in *Potamogetons*, or condensed

branches or terminal buds as in *Utricularia*. Willow twigs may be carried to grow in favorable places.

4. Spores, seeds or fruits may be carried by currents. To make seeds or fruits float, air chambers develop in some parts, and the latter are usually resistant to decay. Occasionally by waxy substances, the parts are made unwettable and hence float. The receptacle is said to provide the float in *Nelumbium*, the ovary in *Alisma*, *Sagittaria*, and species of *Carex*, separate carpels in *Nuphar*, ovary and calyx combined in the cocoanut whose salt-water-resisting air-filled husk and unwettable outer skin, make it perfectly adapted to long ocean voyages; the arillus or third seed-coat is used in *Nymphaea*.

5. Rain-drops may wash spores or seeds from their capsules and carry them away in rivulets to grow in damp places. The little gemmæ are thus carried from the cups on the fronds of some liverworts, as *Marchantia*, and perhaps the bublets may be thus carried from the axils of the leaves in lilies and ferns. The pods of *Anagallis* and *Brunella vulgaris* are said to open in a rain which then washes out the seeds.

VI. Locomotion by the Utilization of the Movement of Animals.

There are two fundamentally distinct ways in which the locomotive power of animals is used by plants for their locomotion; first, parts are made to cling to their fur or feathers or feet; second, seeds protected from digestion by special coats are enclosed in fleshy fruits which are eaten, and the seeds are later discharged uninjured from the animals' bodies.

Looking over the groups of animals, we find that the only ones large enough to carry seeds and fruits, and at the same time of active habits and wide range, are birds and mammals. In special cases, however, insects, snails and even fish may carry seeds.

The different types of dissemination are as follows:

1. Vegetative parts provided with hooks may be carried by fur of animals, as in some cactuses, and possibly the stems with their fruits of our galiums, and *Polygonum sagittatum* may be carried in the same way. Winter buds and other parts of water plants may be carried in mud by the feet of birds as in *Elodea canadensis*.

2. By clinging apparatus of hooks, etc., seeds or fruits may become attached to wool or fur and be carried far, to be finally brushed off or to be shed with them, or spines may be developed which stick into the feet of animals. Mammals, because of their shaggy coats, are best adapted for this mode of dissemination, and accordingly it is common in herbs, and rare in shrubs or trees. Hooks, more or less large and strong, are formed from bracts as in the burdock, from outgrowth of the calyx as in Agrimony, calyx teeth as in *Compositæ*, ovary or part of it as in *Desmodium*, inferior ovary as in *Umbelliferæ*, *Circæa*, the style as in *Polygonum virginianum*, the seed itself as in *Villarsia nymphæoides*. Hooked fruits are numerous but hooked seeds rare, for in the ovary where many are closely pressed together there is not room for the development of hooks. Spines which project straight from the fruit and stick into the hoof of animals occur in a few plants, and in other cases there are formed many projections arranged in lines so that the fruit clings in wool or hair as a comb does.

3. A sticky substance is formed which makes fruits or seeds cling to the fur, feathers or feet of animals, a peculiarity particularly common in water-plants. This may be formed either by special glands or simply over the general surface. It may be on the calyx as in *Salvia glutinosa* and *Plumbago*, in the ovary as in *Linnæa borealis*, on the seed itself as in *Collomia*, and rarer cases are known where it occurs upon other parts. In parasites the seeds are usually sticky, but doubtless this is as much to make them cling to branches as to secure locomotion.

Another very important phase of this subject is the carrying of seeds in the mud which clings to the feet of birds and hoofs

of mammals, an extremely effective mode of locomotion. Birds nearly always carry some mud and seeds with them from pond to pond, and doubtless this is the explanation of the extremely wide range of most bog and water-plants.

4. The heavy nuts of trees are moved to some extent by squirrels and other small animals, which carry them off for food. Many are dropped by them *en route*, and others are stored up but never used and may come finally to the ground and germinate. Blue Jays are said to store up quantities of nuts which they never use. Probably oaks, hickories, etc., secure a part of their locomotion in this way. Such seeds are not intended to be eaten and many of them have a bitter taste which to some extent prevents it.

5. By the development of nutritious and pleasant tasting pulp in which seeds, protected from digestion by hard coatings, etc., are imbedded, animals are made to carry seeds for long distances, discharging them finally from their bodies under conditions most favorable for germination. This is the true philosophy of edible fruits in Nature. To protect them from being eaten before the seeds are ripe, they are usually green in color and may even possess spines or stinging hairs, but have some bright color making them as conspicuous as possible when they are ripe. Thus when they ripen early in the season they are red, this color contrasting the best with the green of foliage —but when they ripen after the foliage has turned red, they are often purple, and when they grow in dark or shaded places, they are often white, as in many parasites. Birds are particularly adapted to this mode of dissemination. Their smaller size and habits make it possible for the plants to attract them more readily than the larger mammals; hence berries are particularly common on trees and shrubs, less so on low herbs, though they do occur upon the latter and are eaten by ground birds. Though many seeds become destroyed in the animal's body, many others pass through without injury, and in some cases actually germinate better than these which have not been swallowed. The seed may be made indigestible either by its coats becoming

stony as in the grape, or by inner part of the ovary ripening to a stone as it does in the peach and cherry. In many cases the seeds are enclosed in a core which is not eaten but thrown away after being carried some distance. Seeds escape being crushed by the teeth either by their minute size, or by being large and bitter, or by being very slippery, or by being too hard.

The pulp may be formed from bracts as in juniper, from the receptacle as in the strawberry, from the calyx as in wintergreen, from wall of the ovary as in the grape, from placentæ as in watermelon, from the arillus as in mace, yew, from the funiculus as in some cactuses, from hairs on the interior wall of the ovary as in aroids and the orange, or the pulp may be formed from several of these combined.

6. In some plants, seeds or fruits, more or less protected by hard coats against danger of digestion, look so remarkably like insects that it is believed by some botanists that their resemblance is not accidental but the result of adaptation, and that they are swallowed by animals in the belief that they are insects, and are later discharged uninjured. Such are the seeds of the castor bean and of *Jatropha*, which resemble beetles, and fruits of *Scorpiurus* and *Calendula* which resemble caterpillars. But the subject is not yet settled. In other cases very brightly colored seeds may be swallowed precisely as other brightly colored objects, such as bright pebbles, etc., are. Certain seeds, *Melampyrum pratense*, resemble very closely the eggs of ants and are probably carried off in that belief.

7. Man has produced great effects upon plant locomotion. He has carried useful plants from one continent to another and through all lesser distances: along with the seeds of these, he has accidently introduced others, which may run wild and become weeds, and finally in various accidental ways he has scattered them around the globe. All of this locomotion is, however, of the incidental, not of the adapted kind.

VII. Utilization of the Power of Gravitation.

As already pointed out this force working in a vertical instead of a lateral direction is of little use in dissemination. It causes seeds to roll down slopes, and undoubtedly aids in the scattering of heavy nuts, which have their outer walls so built that they are elastic, and, falling with force they may strike stones or roots or lower branches and bounce away considerable distances, and this may be helped by wind, water currents, etc.

III. Some Special Adaptations Connected with the Locomotive Parts.

In addition to the adaptations to locomotion proper, there are various arrangements connected with the locomotive parts which we cannot here more than mention. Such are the power of planting themselves by utilization of the movements of hygroscopic tissues which bore them into the ground as in *Erodium* and *Stipa pinnata*. In other cases the fruit stalk turns from the light and places the seeds in clefts of rocks on which the plant grows as in *Linaria Cymbalaria* of Europe. Some plants place their seeds in protective positions while they are ripening, as many water plants which draw them by spirally shortened stems under water. Some seeds have modes of protection against germinating in the fruit, others special arrangements for rapidly absorbing water and perhaps even fastening themselves to the ground. Some fruits open only in favorable weather, others, as in cones of certain pines, appear to open only when scorched by fire, and there are many other arrangements which space does not allow us to mention.

IV. Suggestions for the Study of Plant Locomotion by Local Botanists.

From the foregoing outline, which is intended to be suggestive rather than exhaustive, it will be perceived that in plant locomotion, local botanists have a most attractive and profitable field for study. There is opportunity for a great amount of original work in it. These questions have been much studied in Europe, but very little in this country, and it is needful that every species shall be examined here, whether studied elsewhere or not.

The student may start with the assumption that every plant has some mode of locomotion; his task is simply to discover what that is. To do so he has only to watch closely enough the plant especially as it passes from flower to fruit. Then secondly, it will help him if he studies the locomotive agencies and observes what plants are moved by them. He should, for example, watch the berries to see what animals eat them, and the birds to see what berries they eat. The seeds floating on water or driven along the roads by wind, or which cling to his clothing or the fur of animals, or (if he be also an ornithologist,) which occur on the feet or in the stomachs of birds should be collected and identified. To aid in this latter work, he should make collections of seeds and fruits of our water plants; indeed our natural history societies should make such collections as a part of their museums. A collection of seeds and fruits of native plants arranged according to agencies of locomotion would be most instructive and interesting as well as valuable for comparison. The botanist who would undertake as his specialty to work out the locomotion of every plant in a given district and to make a collection of seeds and fruits to illustrate it would have a no less interesting and serviceable specialty than he who works

out the occurrence of plants in a given district and collects an herbarium to illustrate it; indeed in the present state of knowledge he would have one likely to be of even more real service to science.

There is need also of experiment. How far certain seeds may be carried by winds of certain strength; how long seeds may float in water without losing their power of germination; what seeds resist digestion while passing through the bodies of animals, and many other principles still need that statistical study which is the only foundation for true knowledge.

I would propose finally to the botanists of Acadia that they should communicate their original observations upon locomotion and other biological topics to this society, and that the society publish them in brief, precisely as it has published notes on plant distribution, and that nothing should be admitted to the list which does not rest upon direct personal observation. In this way may be systematically collected a body of reliable fact as a basis for further elaboration of principle, and as well for the preparation of that true natural history of our native plants which is the real goal of all our endeavors.

Smith College, Northampton, Mass., June 1, 1895.

Note, October 5.— As this paper goes to press I find myself well-nigh convinced by recent discussions of the subject that, all things considered, the term *Ecology* is a better one for the study of adaptation than *Biology*. In this case to express the study of plants, *Phytoecology* would be better than *Phytobiology*.

ARTICLE II.

HISTORY AND PRESENT STATE OF THE ICHTHYOLOGY OF NEW BRUNSWICK.

By Philip Cox, A.B., B.Sc., Ph. D.

CHAPTER I.

Few countries of equal area surpass New Brunswick in the extent and variety of its inland waters. Rivers and streams, lakes and ponds, are scattered over the surface to such an extent as to form, with short portages, water communication between the most remote sections, while the undulating nature of the surface favors the formation of springs and brooks, which, flowing from forest regions, are not only deliciously pure and cool, but sensibly lower the temperature of the larger streams and rivers even at the hottest season of the year. This cooling influence is further increased by the melting of snow often prolonged into early summer, especially in deep and narrow forest valleys and on wooded northern exposures. Thus it happens that the main rivers of the province, the St. John, Miramichi, Nepisiguit and Restigouche, attract swarms of anadromous fishes which enter and thread these watercourses and their numerous tributaries far into the interior. Hence the ocean's flocks and herds are annually spread all over the province, where they linger for weeks or even months; and, as many are the choicest and most valuable food-fishes, the inhabitants are not only supplied with an excellent article of diet, but also

enabled to pursue a profitable occupation — catching, selling, and exporting the fish. To enable one to appreciate the value of this industry it is only necessary to state that the salmon, bass, shad, smelt, and alewife, are among these annual migrants; and hence the importance of preserving free from obstruction and pollution the great provincial waterways, which attract and distribute them throughout the interior.

The sea-going forms, however abundant and valuable, constitute only a part of the rich and varied fish-fauna of the province, for the more inland water-system is the home of a variety of food-fishes more or less peculiar to fresh water, such as the whitefish, cusk, togue, winninish, trout and perch, which are thus accessible to the population beyond the range of the more anadromous forms. In addition, the waters teem with many smaller species, not directly valuable as food-fishes, but of much economic importance as furnishing food for the more highly prized species. In this way the whole ichthyology of a region becomes a system of life, whose parts are so mutually essential, so balanced and correlated, that any disturbance, the thoughtless destruction of even the most insignificant forms, may re-act fatally on the whole. To preserve, then, nature's healthy balance, and maintain undiminished the supply of food-fishes, call for an intimate knowledge of the whole ichthyology of the region in question.

Thus, from an economic as well as scientific view, New Brunswick holds out many inducements to students of nature and to practical investigators as well, to examine its varied fish-life with the view of solving the many difficult problems bearing on the healthy maintenance of one of its chief industries and sources of wealth. So far the results have been disappointing; the ichthyology of

the province is still in its infancy; nor is it complimentary to the scientific spirit of provincialists to be reminded of the fact that whatever little of a systematic character has been done is, with one exception, the work of foreigners.

CHAPTER II.

The earliest reference to our fishes is to be found in "L'Histoire Naturelle de l'Amérique Septentrionale, par Nicholas Dénys, Paris, 1672." The author lived in Acadie (Nova Scotia and New Brunswick) twenty years or more, and carried on extensive fishing and trading operations at several points on the coast between Cape Breton and Gaspé, especially at Bathurst and Point Miscou in New Brunswick. Though he enumerates but a few species, principally the staple food-fishes and a few others conspicuous by their large size and peculiar habits, and refers to many smaller river and marine forms in a general way, the ichthyological student is able to identify about twenty species at least. As already stated, they are principally the leading food-fishes, such as the salmon, cod, mackerel, shad, herring, trout, haddock, sturgeon, smelt, etc.; but he also speaks of three kinds of rays, a sardine, an anchovy and a flat-fish, which are hard to identify from the very meagre description given. One of the points of greatest interest, however, is found in his description of the "Espadon," which would seem to be the "saw-fish," *pristis pectenatus* Latham * an uncommon visitor, and

* "L'espadon est un poisson gros comme une vache, de six á huit piéds de longueur, qui va en diminuant vers la queuë; il a sur le nez un espadon, dont il prend le nom, qui est long d'environs trois pieds, large d'environs quatre bons doigts; il y a de deux costez de cet espadon des pointes longues d'un pouce, de pareille distance les uns des autres, et va étraissessant vers le bout; il ne plye point et est dur et fort roide.—*L'Histoire Naturelle, par N. Denys, Paris, 1672.*"

not, to the writer's knowledge, since recorded on either the coast of New Brunswick or Nova Scotia.

It is regrettable that our literary, historical, and natural history societies and associations do not take concerted measures to have these old and quaint, but intensely interesting and attractive works, re-published, and thus made accessible to scholars and students of nature, — these "foot-prints on the sands of time."

In "A Historical and Statistical Account of New Brunswick, with Advice to Emigrants," by Rev. W. C. Atkinson, A. M., Edinburgh, 1844, occurs a list of some provincial fishes; but beyond the interest attached to it as one of the earliest catalogues, it claims little attention. From a scientific point of view it is of no value, for besides its many inaccuracies it affords ample evidence of the author's want of knowledge of this section of natural history. He not only includes such extra-limital species as the bluefish, *P. saltator* Lacépède, Spanish mackerel *S. maculatus* Mitchill, and others of similar range, but the squid and shrimp, which are not *fishes* at all; from which it must be inferred that the author of this attractive little book had not a sufficient knowledge of ichthyic physiology to render his determination of species actually observed of much scientific value. The writer, however, finds a pleasure in recommending the little volume to all students of the history of New Brunswick, who must feel grateful to the author for recording much which might otherwise have been lost, of interest in the early settlement and growth of the province.

Three years after appeared "New Brunswick," by Abraham Gesner, Esquire, London, a volume dealing with the geology, settlement, and general resources of the province. The author believed in the universal distribution of the same animal life over any area wherein

the same general physical and climatic conditions existed; for the "description of the productions of a single province would apply to almost the whole of the northern part of the great continent" (p. 355); forgetful of the fact that great gaps often occur in the distribution of some special form, even in cases of very restricted faunal provinces, and that the theory becomes more objectionable when sought to be applied to an extensive region. For this reason then, his list, comprising sixty-four species, culled from Richardson's "Fauna Boreali Americana," Pennant's "Arctic Zoology," and several American journals of science, must be viewed with suspicion, nor any surprise felt at the presence in it of many apocryphal, extra-limital, and other doubtful species. At the same time, it must be borne in mind that Dr. Gesner was a man eminent in many branches of science, fully competent to become an authority in ichthyology, did his tastes and opportunities lead that way, and well able to appreciate the worth of scientific methods and accuracy. The "Gesner Museum," the first to be established in the province, bears witness to his great energy and wide attainments. Doubtless, the great majority of species included in his list, and subsequently identified as provincial fishes, were actually observed and determined by him; but the reader is at a loss to know what they are or how to separate them from the rest, consequently no satisfactory criticism of the catalogue can be made.

CHAPTER III.

To Moses H. Perley belongs the honour of having first published a systematic and descriptive list of New Brunswick fishes in a series of "Reports on the Sea and River Fisheries of New Brunswick," Fredericton, 1852. This list became the basis of all subsequent ones, not only for the province, but for Nova Scotia as well. In this the author very modestly claims not to be a professed naturalist, but an *observer* of nature, and for this reason begs indulgence at the hands of critics. A careful examination, however, of the little volume must convince the reader that its author was a scholar of varied attainments, a close and accurate observer of nature, careful and cautious of statement, brief but lucid in narration. A power of condensation and ability to seize the most salient features of form, markings, structure, and habits of fishes, render his descriptions exceedingly pleasing and instructive. If he were not a "professed naturalist" it was due entirely to his modesty; for in the correctness of his determinations and general stability of his list, is found evidence of a high order of scientific knowledge. That he included a few forms, now recognized as the young, or seasonal, or other stages in the life of another species, argues nothing. The general history of ichthyology in America and elsewhere scarcely contains the name of an author, however eminent, whose determinations have not, in many cases, proved incorrect; and it bears additional testimony to our author's scientific acumen that he recognized the minute distinctions on which these so-called species of Cuvier, Valenciennes, Storer, and DeKay were founded; for they were all regarded at that time as specific forms. Moreover, some of these he professes not to have seen, but admitted on Dr.

Storer's authority. Bearing this in mind, it may be said that after forty years Perley's determinations are essentially unchallenged. He established no new species, it is true, for such an opportunity does not fall to every man, and Perley was not a disciple of the more modern school of species-manufacturers, who are flooding the fields of zoology with visionary genera and species; but, in identifying specific or transitional forms already named by the above-mentioned authors, he exhibited an accurate acquaintance with the details of anatomy. It is therefore with more than ordinary pride the student turns to the labours of this pioneer ichthyologist and follows the footprints of the man, the scholar, and naturalist who laid the foundation of the science in New Brunswick.

Perley's list contains the names of sixty-two so-called species; but since his time the development of cyprinids has received more attention, and the "Shining Dace," *Leuciscus argenteus* Storer, has been shown to be the young of the River Chub, *Semotilus bullaris* Rafinesque. Again, the "Salmon Trout," or "White Sea Trout," *S. trutta*, of his catalogue is undoubtly the sea-run or anadromous representative of the common Speckled Trout, *S. fontinalis* Mitchill. Under the name of "Britt," *Clupea minima* Storer, he includes, on the latter's authority, a small herring, which is now regarded as the young of the two ordinary herrings of our coast. The common codfish has perhaps the widest range of any, and must therefore be expected to exhibit much variation in size and colour. One of these varieties is known as the "Rock Cod," which was elevated to specific rank by Storer, Mitchill, and others; and, occurring on our coasts, was very naturally assigned a place in our author's list. Moreover, Prof. Gill has shown that the "Little Sand Dab," *Platessa pussilla*, is the young of the common flounder, *P. plana* Storer, and it must therefore be re-

moved from the catalogue of provincial fishes. Discarding then these five forms, there remain fifty-seven well established species, representing the ichthyological labours of Moses Perley.

The eminent natuarlist, Theodore Gill, M.D., Ph. D., to whose researches the science of ichthyology in America is so largely indebted, published in 1865 a "Synopsis of the Fish of the Gulf of St. Lawrence and Bay of Fundy" (*vide* "Canadian Naturalist," Vol. II., 1865), which was followed in 1873 by a "Catalogue of the Fishes of the East Coast of North America." Though not to be accepted as an authority on provincial fishes, these works proved of much value to subsequent investigators on account of the information they gave respecting species liable to occur in the littoral waters of New Brunswick. For this reason Prof. Gill's name and labours deserve honourable mention, at least, in any review of the progress of ichthyology in Eastern Canada.

Such seems to have been the state of the science in New Brunswick when there arrived in 1866 that versatile writer and accomplished traveller and scholar, A. Leith Adams, M. A., F. R. S., etc., staff-surgeon-major of Her Majesty's 22nd regiment. An admirer of nature, a scientist, already an author of some repute on the natural history of India and the archæology of the Nile and Maltese Islands, he was well equipped through taste and training to enter eagerly the fresh fields this corner of the New World presented. He plunged at once into the wilderness. No difficulty daunted, no toil discouraged him: he bore with cheerfulness the hardships and exposure of long winter journeys through the forest, and the discomfort and torture caused by swarms of mosquitoes and other insect pests during his summer wanderings over the barren lands and inland water-

courses. His energy was remarkable; his capacity for intellectual work apparently unlimited. No sooner did he return from a trip of exploration, than dispatching his official duties, and putting the results of late investigations in shape, he was off again to some remote region. Nothing escaped him. He was equally at home in the Indian's wigwam, studying his habits and listening to his traditions—the uncertain twilight of a savage history; collecting stone implements, or digging into the kitchen-middens of some prehistoric camping-ground; in the log-cabin of the back-woods settler, observing the customs of frontier life and learning of the trials and hopes of the hardy pioneer; in the lumberman's shanty away in the depth of the forest, studying woodcraft, the effects of climate, and the winter habits of birds and animals; in the hunter's "lean-to" beside a solitary Indian guide, whither he had gone to observe the battle between the cunning and intelligence of fur-bearing animals and the trapper's craft; along with the chance poacher or pot-hunter to witness with loathing the cowardly and merciless slaughter of the lordly moose as it wallowed helpless, cut, and bleeding in the deep, sharp-crusted snow, in order to be the better able to denounce the barbarous destruction of the noblest game-animal of America; in bark canoe, on river or lake, capturing the finny denizens of the waters, or wading through stagnant ponds and quag-mires collecting the oozy reptile; in the trader's store-room measuring and comparing the skins of animals, and drawing conclusions, alike interesting to the general reader and valuable to men of science; or in rocky gulch of mountain stream, on peaty barren, or bed of tarn, studying the geology of the region.

But while prosecuting his field work with ardor, he was also a student of books, having an inti-

mate knowledge of almost every scientific publication which in any way bore on the natural history of the country, as anyone reading that charming volume, "Field and Forest Rambles," will perceive. This book, containing the results of the labours of six years in New Brunswick, is not only brimful of useful and scientific information, but a real literary gem, written in a style alike pleasing and attractive. In it the scientist, naturalist, and poet, are blended harmoniously; and the dress is now the language of fact and then the gorgeous livery of a lively imagination. A lover of nature in all her various moods, with a strange susceptibility to what is poetic and mystic in her finer influences and manifestations: never more at home than when the winter moon is casting the weird shadows of forest trees on the fleecy mantle around him, or the solitary owl with ominous voice is laughing into the death-like stillness of its lonely haunts; or in canoe on the midnight waters of forest lake, reflecting the pale lights of heaven, and its darkened wall of trees re-echoing again and again the scream of the Northern Diver: Dr. Adams, in his little book whispers of the spirit of the wilderness, and the beauty and charms of its picturesque scenery. And yet, as already observed, the clear, brief, and accurate description of the scientist, will be found to exist side by side with the artist and poet's richness of imagery and charming delicacy of thought and expression.

It is, however, with Dr. Adams, as an ichthyologist and his contributions to the science in New Brunswick the writer has most to deal. He enumerates one hundred and three species, including all those in Perley's list with one or two exceptions, besides twenty-five others on the authority of Dr. Gill (Synopsis of the Fishes of Gulf of St. Lawrence and Bay of Fundy, Canadian Naturalist,

1865); Dr. Holmes' Ichthyology of Maine, 1861–2, and some other American authors; but, as there is no certainty of these having been taken in the waters proper of New Brunswick, they cannot be considered in this review, which seeks to ascertain the number of undoubted species so far recognized. Moreover, further reductions must be made of all duplicated species, where the young or some local or seasonal variety was regarded as a distinct form. For instance, the landlocked smelt, *Osmerus mordax* Gill, and the landlocked salmon, *S. Gloverii* Girard, were considered as species distinct from the sea-run or anadromous forms, a position no longer tenable; at least more extensive observation and various experiments tend to establish their specific identity. The same remarks will apply to two other nominal species, the New York Shiner, *Leuciscus chrysoleucus* Mitch., and the Banded Dace, *L. rittatus* DeKay, which are specifically equal to the shiner, *Leucosomus Americanus* Storer, and the Red Fin, *Leuciscus cornutus* DeKay. Then again there is, in his catalogue, a Leuciscus, which the doctor did not determine; and, as no specimen has been preserved in our province, it seems impossible to include it in this list.

It will then be apparent that Dr. Adams added eleven species to the known provincial fishes, all of which are certified as having been "verified from personal observation," though it is unfortunate specimens were not deposited in any museum or collection in the province. They are as follows:

Pumpkin Seed, *Pomotis appendix* Mitchill.
White Lake Bass, *Labrax albidus* DeKay.
Many-Spined Stickleback, *Gasterosteus aculeatus* Brevoort.
Sea Raven, *Hemitripterus Acadiensis* Storer.
Labrador or Northern Sculpin, *Cottus labradoricus* Girard.

Sea Swallow, *Dactylopterus volitans* Lacépède.
Radiated Shanny, *Pholis subbifurcatus* Storer.
Thick-Lipped Eelpout, *Zoarces anguillaris* Storer.
Spotted Wrymouth, *Cryptacanthodes maculatus* Storer.
Chub Sucker, *Moxostomus oblongus* Ayres.
Pickerel, *Esox reticulatus* Le Sueur.

It must, however, be borne in mind that Dr. Adams had followed Prof. Gill in the doctrine of "Zoological Provinces," by which, whenever a species is known to occur in any part of a so-called province, it is attributed to the whole. Maine and New Brunswick are so classified by our author (*vide* p. 214); and a Basking Shark, *Cetorhinus maximus* Blainville, taken on the coast of Maine, is referred to New Brunswick in the catalogue "verified from personal observation" (*vide* p. 306, note). In this way, too, the occurrence of the Ghost Fish, *C. inornatus* Gill, in his list may be accounted for.

The history of this fish is interesting as illustrating the general weakness of modern scientists. Every student of nature is well aware that she occasionally shows the wealth of her resources in albinism, melanism, and other strange and accidental variations from a given type. Not many years ago, the writer took a white specimen of the common eel, *Anguilla rostrata* L., apparently in good health and condition. It seems that in 1863 an albino wrymouth, *C. maculatus* Storer, was sent to Prof. Gill of Philadelphia, who proclaimed it a new species, *C. inornatus*, with the significant title of "Ghost Fish." The Spotted Wrymouth is reported by J. M. Jones, F. L. S., as "a rare visitor to Nova Scotia waters," and he adds that a fine albino specimen was taken in Halifax Harbour in 1860, and that such are not uncommon. (Canadian Naturalist, Vol. II., 1865.) It is just possible that Dr. Adams looked upon New Brunswick and Nova

Scotia as constituting a marine ichthyological province, and referred these Nova Scotia specimens to the whole supposed range; but it is more probable that actual specimens from our littoral waters, rare though they be, came under his observation. It is needless to add that the professor's "Ghost Fish" has vanished from the lists of American fishes, but not soon enough to prevent its insertion in the doctor's list. It is unfortunate that localities were not assigned to these new and rare forms, as it would have removed all doubt and misconception. In March, 1894, a very fine specimen of *C. maculatus* was taken in St. John Harbour, and identified by the writer. It was donated to the Natural History Society by Samuel W. Kain of the Customs.

American writers assert that *C. maculatus* has no lateral line; but the specimen in question had a well-defined one on the anterior half of the body, showing a regular line of pores. In spirits it loses its characteristic colouring, rapidly becoming whitish.

A very rare and extra-limital species is the Sea Swallow, *Dactylopterus volitans* Lacépède. It would not excite surprise to have the accidental occurrence of this sub-tropical gurnard reported from the south-eastern shore of Nova Scotia, whither it might stray from its congenial habitat, the Gulf Stream; but its presence in the coastal waters of our province is more than a surprise. In the very nature of things it must be an exceedingly rare visitor, scarcely deserving a place in the lists of our fauna.

Another very uncommon fish is the Radiated Shanny, *Pholis subbifurcatus*. It was first described by Storer, "Report on the Fishes of Mass., 1839"; but its presence in provincial waters was first recorded by Dr. Adams. The next mention is by J. M. Jones, who reports its capture in a trawl net off Halifax Harbour by the Speedwell Expedition of the United States Fishery Commission,

1877. (See List of the Fishes of Nova Scotia, Nova Scotia Institute of Nat. Sc., Vol. V., Pt I., 1879.)

The Sea Raven, *H. Acadiensis* Storer, is not by any means a rare fish in St. John Harbour, where it is taken in the weirs. Several of such specimens have been examined by the writer. Both it and the Thick-lipped Eelpout, *Zoarces anguillaris* Storer, occur in the Miramichi Bay. *Z. ciliatus*, a variety of the latter, is found in the same bay. They differ in the relative size of the head and jaws.

The fresh water species, *Moxostomus oblongus* Ayres; *Esox reticulatus* Le Sueur; *Pomotis appendix* Mitchill; and *Labrax albidus* DeKay, call for a few observations.

The first, known as the Chub-sucker, is quite common in small lowland streams; but is disappearing from its former haunts since the introduction of the pickerel. The latter had not been planted in the waters of New Brunswick in Perley's time; but has become quite common in the lower course of the St. John, which is the northern limit of its distribution in the province. The third, *Pomotis appendix*, is a percoid fish, locally known as the "Long-eared Sun-Fish," and quite common from Maine to Louisiana. Dr. Adams assigns no locality for it in New Brunswick; but the White Lake-Bass, he tells us occurs in "Oromocto Lake, one of the headwaters of the Magaguadavic." Special inquiry was made by the writer about this fish from settlers around the lake, but none had ever seen it.

The Many-Spined Stickleback is found all over the province; but the Northern Sculpin does not appear to have been observed on our coast since his time.

To sum up: Perley identified fifty-seven specific forms, Dr. Adams added eleven new ones, making a total of sixty-eight species, as the joint work of these two pioneers.

CHAPTER IV.

A few additions have been made since, and it will be the writer's object to describe them in greater detail. All have been deposited in the Natural History Museum, St. John; and whenever a doubt existed regarding the determination some of the best authorities in North America were consulted.

Couesius plumbeus Agassiz. This is a species new to our provincial fauna. Wm. M. McLean, Principal of the St. John Grammar School, and the writer collected several specimens from the upper St. John and Madawaska rivers, as well as from the Squattook and Temiscouata lakes drained by the latter, in July, 1893. They are small cyprinids ranging from three to five inches in length, and varying greatly in detail according to locality, the extremes of a series seeming to constitute well-marked sub-species. Some of the constant features may be here briefly alluded to.

The scales are cycloid in form, and about seventy may be counted in the lateral line, eleven between it and the dorsal, and eight between the lateral line and the ventrals. The dorsal is inserted slightly behind the last ray of the ventral, and has eight rays, the anal fin having an equal number. The large eye is contained one and one-fifth times in the snout and one and one-third times in the interorbital space; the mouth is terminal, and the maxillary scarcely reaches the orbit.

On the other hand the coloration is extremely varied. In some specimens the plumbeous lateral band is scarcely distinguishable; in others nearly black: in the majority the body is fusiform; but in a few, heavy and chub-like anteriorly. Some strange anomalies occur. One speci-

men had the scale formula 12–70–9, the snout very short, the head broad and flattish, and the lateral band invisible.

Being denizens of both fluviatile and lacustrine waters, much variation must be looked for, even in those details of general physiognomy which are regarded as specific of fishes of more uniform habitat and restricted range. Food, temperature, and the character of its general environment must, in time, stamp their influence on the less persistent structural elements of the creature so conditioned, and slowly produce that divergence of type to which the very existence of species is doubtless due. The cyprinids are peculiar among fishes in this respect, which renders the family one of the most difficult to diagnose and classify. Moreover, there is much confusion at present in the literature relating to the genus *Couesius*, and a more thorough examination of a large amount of material from various sources may perhaps show that many of these apparently aberrant forms may be entitled, if not to specific, at least to sub-specific distinction,

Couesius prosthemius Cope.

Though this distinguished herpetologist and naturalist considered this form a good species, there are many reasons for simply regarding it as a strongly marked variety or perhaps sub-species of *C. plumbeus* Agassiz. Even Günther adjudged it of specific rank (*vide* VII. p. 442); but the writer is not aware that he had then seen the last described species. This fish occurs in Loch Lomond, St. John County, where it was identified by the writer in June, 1893. It is very abundant, and would seem to attain a larger size than in any other recorded place in America, except perhaps in Lake Superior, some specimens being over six inches long. The following description will suffice: Body elongate,

sub-fusiform, heavy anteriorly; back slightly arched; head rather small, and mouth inferior and oblique rather than terminal as in *C. plumbeus;* snout descends abruptly. Eye small, contained four times in the length of the head, which latter is contained four-and-a-half times in the body. Profile of head straightish, flattened on top, with a slight medium depression. Dorsal inserted over last ray of ventral, and like the anal has eight rays. The scale formula is 11–64–8, varying slightly in different individuals. Coloration: Above almost black, below whitish, lateral band dusky.

This fish spawns about the middle of June, when the top of the head, and scales of the lateral and dorsal parts, are beset with minute horny tubercles, rendering it harsh to the touch.

Loch Lomond is drained into the Bay of Fundy by the Mispeck river, and has, therefore, no fresh-water connection with the St. John or any other river system. Hence this form is localized, confined, as it were, to a very limited lacustrine area, and does not exhibit the aberrant character of the last species.

A single specimen of *Couesius* was taken from Spruce Lake, St. John County, by the writer in September, 1893, which differed in some particulars from either of the two above-described, and is evidently the form reported from Free Port, Maine, by W. C. Kendall and Hugh M. Smith (*vide* Bulletin U. S. F. Com., pp. 15–21, 1894).

The body is fusiform, its depth being four and three-quarter times in its length. Profile very much arched. Head conic, convex on top, four and a quarter in body. Mouth terminal. Eye large, three and a quarter in head. Scales 10–60–7, D. 8, A. 9. Teeth 1.4–4.2. Length, three and three-quarter inches. Colour: dark—

olive above, whitish below; an intensely dark band around snout, expanded on opercle, and ending at the base of the caudal in a rhombic-shaped spot. Cheeks, axils of paired fins, and base of anal, bright red.

The intensely dark lateral band, strong convexity of dorsal outline, teeth and scales, would, if constant, entitle this fish to sub-specific rank. It bears a close resemblance to *C. greeni*, from Fort St. James, B. C. (*vide* Bulletin Natural History Society of B. C., 1893). The strikingly arched character of the anterior dorsal region, in which the head, too, participates, was also observed, but to a less extent, in smaller specimens of *C. plumbeus*, and may be a feature of the immature fish; but this is rather opposed to the general rule that dorsal convexity increases with age, though cephalic flattening may take place. On the whole there is need of a wide and thorough investigation to settle satisfactorily the many obscurities in connection with this whole genus.*

Phoxinus neogaeus Cope. Minnow.

In 1888 this little cyprinid was first reported from the province by the writer, who collected some in a small pond in Maugerville, Sunbury County: and in May, 1893, he described others from Dark Lake, in the vicinity of St. John. In September of that year specimens were taken from Garnett's Lake, a few miles from Loch Lomond, and others were obtained from a small pond near Anagance, Kings County. The Maugerville specimens are larger than the Michigan and Iowa fish first described by Prof. E. D. Cope, of Philadelphia, in 1886, being four inches long instead of three. The body is roundish, compressed posteriorly, the profile being nearly

* While this article was going through the press, the writer took many specimens of this variety from the Water Works Lake, some miles from St. John. As the localities are remote and specimens identical, it would seem to point out this form as a well marked sub-species.

straight. Head large, compressed laterally. Mouth large oblique, with a narrowed and bluntish snout, and the lower jaw projecting. The maxillary reaches the front of the eye, which is large, and contained three and a half times in head, three-quarter in snout, one and a third in interorbital space. Fins well developed. The height of the dorsal equals the length of the pectoral, or the distance between the pupil and posterior margin of the opercle. Dorsal inserted behind the anal and midway between the front of the orbit and base of caudal. The scales are small, much embedded in the skin, and showing about eighty-two in a longitudinal series. Lateral line incomplete, disappearing a little in advance of the dorsal. Back dusky, sides with a dusky band, a lighter one above; below whitish. Dorsal and caudal dusky, the other fins light, edged with dark. Head four, and depth four and a half times in body. D. 8, A. 8. Teeth 2.4–4.2 on pharyngeals. These specimens were obtained in July after the spawning season when they were likely out of condition, which may account for their attenuated and compressed form, dull colour, and the absence of crimson on sides and in axils of pectoral fins, which is said to be characteristic of the Michigan fish.

The specimens from Dark Lake were procured in May and differ in many particulars from the above; but are almost the counterpart of the Anagance variety obtained in September. The largest specimens, and scores were examined, are two and three-quarter inches in length. The head is very heavy; the profile well arched; there is an angle at the nape; the head is curved to the nostrils; the muzzle is short and decurved, with a blunter snout. Anal fin mostly nine-rayed. Dorsal inserted farther back by two-thirds the length of the caudal. Lateral line longer. An intensely black band running

from snout to caudal, forming a broad conspicuous patch on operculum. Head three and two-thirds, and depth four times in body. Sides below lateral band rosy. Females larger and more richly coloured than the males. Gill-membranes not forming a fold at the isthmus. Branchial leaflets stouter, oblong not acute, filling gill cavity completely and causing it to bulge. Gill rakers shorter, less acute and with broader bases. Teeth 2.4 — 4.1 or 4.0, more acute and hooked. The Garnett lake variety are almost the counterpart of the Maugerville specimens, reaching a length of five inches.

While these differences may not be entitled to specific recognition, it must be remembered they are constant, and many species have been established upon fewer and less important characters; nevertheless, the writer believes that this principle has been pushed to an unwarranted length, needlessly multiplying species and perplexing the whole science of ichthyology. Just how far modification must extend, and what structural and other diversities must exist before a species can be declared, will always be a subject of contention; still it behooves men of science to be as conservative as possible, and slow to stamp with natural isolation and finality forms which are but initial steps in that process of development which matures in the production of well-marked species. These little fishes furnish a good illustration. They occur only in small ponds, widely separated, and from which predaceous fishes are entirely excluded, each set having a very restricted range with conditions of life peculiar to itself. As the creature is but the vitalized history of its environment, when the latter differs in two or more cases, dissimilar products must result. In this way what may have been in past ages a fairly uniform species, scattered over an immense area more or less accessible to all, has,

in more recent times, and under the results of drainage and from other causes, either become extinct, or maintained its existence in small and isolated areas, becoming in time a form peculiar to its own surroundings. Dark Lake, with a name suggestive of its shaded waters, and the little woodland pond at Anagance, hidden away in the sombre forest, would be expected, other things being equal, to affect an ancestral type in the same way; while the marshy pond in Maugerville, with extensive grassy intervales on all sides, and Garnett's lake, with its peaty bottom and surrounding heath, must influence alike the varying and less persistent features of a common parent.

Chrosomus erythrogaster Agassiz. Red-Bellied Dace.

The paucity of cyprinid forms in the province has been remarked on, but a closer study of the fauna keeps adding an occasional new species. The latest found by the writer is the above, which occurs in Clear Lake, Lepreaux, and may reasonably be expected to turn up in other places. Doubtless its diminutive size has caused it to be mistaken for the fry of larger species; yet in the breeding season it is a conspicuous and attractive object.

The body is fusiform: head rather bluntly pointed, with mouth oblique and lower jaw slightly the longer. The maxillary scarcely reaches the orbit. Lateral line very short, as in *Phoxinus*. Colour: back pale brown or olivaceous, with a dark vertebral line, and sometimes on large specimens an ill-defined line on each side of it made up of spots, and extending from occiput to dorsal fin, but generally only a few spots are seen. Sides with two dark bands, the upper narrow extending from the head to the tail, frequently broken posteriorly into spots or disappearing altogether; the lower broader, running from the nose through the eye and ending in a dark spot on the tail. Space between the bands and the latter

and ventral region silvery, red in spring males. Head three and three-quarters in length. D. 7 or 8. A. 8 or 9. Teeth 5–5. Length of largest specimens two and a half inches.

Some smaller examples show the lateral bands confluent on the caudal peduncle, but otherwise are typical. There seems no good reason for regarding it, with Prof. Cope, as a distinct species.

Uranidea boleoides Girard. The Fresh-Water Sculpin. Miller's Thumb.

The presence of this little fresh-water cottoid in the streams of our province seems to have escaped the notice of previous writers and observers. It is, however, by no means rare; but its habit of skulking under rocks and not taking bait readily, as well as its diminutive size, makes it difficult to detect.

Body sculpin-like, heavy anteriorly; head broad and flat, contained three and a quarter times in body. Mouth large, with the maxillary extending to nearly opposite the pupil, and the preopercular spine sharp. Villiform teeth on jaws and vomer. Pectoral fins large, reaching the third ray of the anal. Dorsal consists of eight spines and seventeen rays; the anal of eleven rays. Coloration: Olivaceous above, with dark spots, whitish below. Length three inches.

This species was first reported from the Restigouche River in 1888 by John Brittain and the writer, subsequently collected by the latter from the affluents of the lower Miramichi, and was found dead in the Madawaska, July, 1893.

Uranidea Richardsoni Jordan and Gilbert. Miller's Thumb. Blob.

To this species are referred specimens taken by the writer from Mill Cove Stream, a tributary of the Miramichi, in the vicinity of Newcastle, April, 1892.

Body stout, with a heavy flattened head, the vertex being depressed, and the body tapering regularly to the tail. The head is contained three and two-thirds, and the depth five times in the body. The mouth is large with the maxillary reaching to the posterior edge of the pupil, and jaws equal. Eye moderate, three and a half in head, one in snout, one-half in interorbital space. Pectorals large, reaching nearly to ventrals. Lateral line well marked, decurved opposite posterior end of soft dorsal. Coloration: dark above, with deeper blotches, dull whitish below; fins, with exception of ventrals, dark and mottled. Preopercular spine sharp, not hooked, directed obliquely backwards and upwards, the inferior two being feebly developed. Subopercular spine short, directed forwards. The fin formula is, D. VIII.—17. A. 12. P. 13. V. I.—4. Length four inches.

Uranidea formosa Girard. Miller's Thumb.

As its specific name implies, this is among the prettiest of the fresh-water sculpins. The body is fusiform and slender, the head small, slightly depressed on top behind the orbits, narrowed anteriorly. Profile of head rounded. Head is contained four and a quarter times in total length. Mouth small, jaws equal, maxillary reaching the pupil. Eye moderate, four in head, one in snout, one-quarter in interorbital space, the latter with a groove between the very proximate orbital ridges. Preopercular spine moderately developed, acute, slightly curving upwards, with a small one on edge of opercle below. Subopercular spine directed forward and downward, well developed. Lateral line not conspicuous, disappearing opposite middle of second dorsal. Upper parts dusky, mottled, the more or less regular longitudinal rows of spots being somewhat confluent; sides lighter with spots

of orange; under parts orange-yellow. D. VIII—16. A. 11. V. I.—3. Length two and three-quarter inches.

One specimen only of this species was obtained. It was found by W. M. McLean and the writer floating dead in the Madawaska River, a few miles above Edmundston, July, 1893. As American writers report it peculiar to deep lakes, it is just possible it was brought down by the current from Lake Temiscouata, Quebec, fifteen miles above; but this is quite improbable. It is here retained as a New Brunswick fish, for the writer is led to believe that these fresh-water cottoids have a peculiar facility of easy and natural adaptation to almost any condition of life; so that the same species can equally exist in lake or river.

The description and synonomy of the Uranidea of North America are very much confused. Over twenty-five species and a large number of varieties have been described by various authors, especially by Girard in the "Monograph of the Fresh-water Cottoids," but there is little unanimity among them, and the whole genus needs a thorough revision. They affect lakes, rivers, and cool, rocky streams especially, where they must form no inconsiderable portion of the food of larger fishes, as the togue, cusk, trout, and land-locked salmon. They skulk about in the shelter of bottom objects, darting rapidly across interspaces, and disappearing suddenly, showing in their quick and timid movements fear of lurking enemies. Their principal food is found adhering to pebbles and rocks, or creeping on the bottom, and consists of the aquatic larvæ of the larger insects, with worms and fresh-water crustaceans. Their habits, as before stated, and coloration, render them very inconspicuous and hard to detect; but if a few stones be turned over in the bed of almost any stream at low

water, the observer will be often surprised at the number of these little denizens skulking there out of sight. In the numerous streams and lakes of the province there must be several species of this genus still unrecognized.*

U. gracilis (Heckel) Putnam. Miller's Thumb.

This species is very slender, with the dorsal fins edged with orange or red, a large mouth, and concealed preopercular spine. The maxillary reaches the pupil. In many respects it resembles both *U. formosa* and *U. boleoides*, but can always be recognized by its slender form. It was first reported by the writer from Green River, Madawaska County, in 1894, where it is associated with *U. Richardsoni* and *U. boleoides*.

Coregonus quadrilateralis, Richardson. White Fish.

This salmonoid is found in the river St. John above the Grand Falls and in many of the lakes drained by its tributaries. It is associated with its congener *C. labradoricus* Rich.; but is inferior to the latter in quality of flesh and size. As this is its first appearance in any New Brunswick list, a brief description is here given, taken from specimens collected by Wm. M. McLean and the writer in July, 1893.

Body elongate, roundish, not much compressed. Dorsal aspect not appreciably arched, nearly straight from nape to caudal; ventral aspect curving both ways from base of ventral fins. Head moderate, profile little curved; snout very narrow, pig-like, descending, obliquely truncated, its tip on level with lower margin of the orbit. Preorbital bone as wide as the pupil. Maxillary, wide, short, not reaching the front of the orbit, about four in head. Mouth inferior, small, with no teeth on tongue. Gill rakers short and stout. Coloration: Pale-bluish above, silvery below; sides with dark punctu-

*Since the above was written, the writer found *U. gracilis* in Green River, Victoria County, which he has caused to be inserted above.

lations. Dorsal and caudal dusky; ventrals, anal, and pectorals whitish, the latter margined and deeply pointed with dusky. Head five and a quarter. Depth four and two-thirds. D. 12. A. 11. Scales 9–86–8. Length about twelve inches.

Although, in some details, it bears a close resemblance to *C. Couesi* Miller, and in others to *C. Williamsoni* Girard, it is evidently a local variety of *C. quadrilateralis* Rich., which occurs in the lakes of New Hampshire and and the upper Great Lakes of Canada. Its habits are about the same as those of *C. labradoricus*, except that it is more frequently taken in summer about the mouths of inlets, while *C. labradoricus* prefers the lakes proper.

About the middle of September the white-fish congregate around the mouths of inlets, up which they swarm to deposit their spawn. Brush and hurdle weirs are built across these streams, with narrow gates or openings through which the fish pass to find themselves entrapped in net pounds surrounding the entrances, and so cleverly arranged that the imprisoned fish cannot escape. In some places a mere pretence is made of complying with some law or custom for providing a free passage, narrow though it be; but in many instances this passage is so narrow and shallow that a fish could not get through without danger of stranding. In the face of such destructive fishing, it is a matter of surprise that they maintain themselves in even their present diminished numbers, as compared with their abundance in former years. When so taken, all are gravid and on their way to the spawning grounds a few miles from the lakes. Indeed, it is quite evident to any one visiting the lake region of the upper St. John, and at all conversant with the habits of the white-fish, that there is pressing need of the enforcement of stringent regulations to preserve to the people

this bounty of Providence. Fresh-water and anadromous fishes are more exposed to the ignorance and greed of man, and therefore more liable to extermination than marine food-fishes. For this reason the fishery should be wisely regulated. As evidence of this, the Annual Reports of the Department of Fisheries may be quoted with respect to one district — the region visited by the writer in July, 1893. Only those of 1885–88 are at hand, but they will serve the purpose. Lake Temiscouata and Tuladi River yielded of white-fish in 1885, 600 barrels; 1886, 450; 1887, 420; 1888, 110. Further comment is unnecessary.

Catostomus longirostus Le Sueur. Long-nosed Sucker. The Banded Sucker.

Dr. Leith Adams reports this species occurring in "Seiff Lake Stream of the eastern Schoodic chain of lakes," St. Croix, York County (*vide* F. and F. Rambles, p. 252); but strange to say it is not found in his list. The omission is clearly an oversight.

Wm. M. McLean and the writer took specimens from the upper St. John, Madawaska, and the Tuladi lake, the latter in the Province of Quebec, during a tour of investigation in the summer of 1893. Moreover, Indians report it from the upper waters of the Tobique, but its occurrence there is doubtful, otherwise its presence might be reasonably looked for in the lower affluents of the main river.

The two specimens examined by Dr. Adams were from five to six inches in length; and though they average two or three inches more on the upper St. John, the New Brunswick representatives, so far as known, are much smaller than those of the Great Lakes and more western and northwestern waters of North America, where they exceed the common sucker, *C. Commersoni*

Lac., which attains in New Brunswick a length of eighteen inches. The flatter and longer head and snout, broad rosy band, coarsely tuberculate lips, and minute scales, distinguish it readily from the common species, especially in the breeding season.

Very little is known definitely of the movements of this fish. From what the writer observed and could learn from settlers and Indians, it seems to prefer in summer cold, rapid streams and the deep waters of lakes, being in this respect very unlike the common variety, which finds a congenial home on the gravelly and muddy bottoms of even sluggish streams. In June large specimens are said to be quite common, moving up the thoroughfares of lakes in company with the spotted trout; but their summer habitat is not well known. The immature fish seem to frequent, in summer, lakes and the lower stretches of rivers, at least many are found in such places. As the writer has pointed out a correspondence between the fish faunas of the St. John and Restigouche (*vide* Bulletin No. XI. Natural History Society, St. John), the long-nosed sucker will likely be found in the latter river.

Gasterosteus inconstans Kirtland. Brook Stickleback. Five-spined Stickleback.

This species was first reported a few years ago by the writer. It is very rare in the northern parts of the province, where its place is taken by *G. pungitius*, L., but it is fairly common in the valley of the lower St. John (*vide* Bulletin No. XI. Natural History Society, St. John).

Apeltes quadracus Mitchill. Shieldless Stickleback.

This is a diminutive denizen of the brackish ditches and ponds that are found in marsh lands near the mouths of small rivers affected by the tides. The specific name *quadracus* refers to its dorsal armature, consisting of *four*

spines, three free and one connected with the soft fin. As this seems to be the first record of its presence in provincial waters, where it was found by the writer in October, 1893, a fuller description than usual may be given in an article of this kind.

Body compressed, its depth equalling the length of the head. Dorsal outline arched, highest at insertion of soft dorsal, thence to snout nearly straight. Caudal peduncle very slender, not keeled. No dermal plates. Innominate bones unconnected. Breast covered with a bony plate. Gill membranes connected with isthmus. Free dorsal spines three, the first the longest, and pointing *generally* to the *left*, the second and third to the right and left respectively, but at different angles; the fourth is joined with the soft dorsal. Bases of free spines between two bony ridges. Coloration: dusky above, mottled; silvery below. Ventral spines, coral red. Fin formula: D. III — I, 11; A. I, 8. Length, one and one-half inches. Mouth of Little River, near St. John.

It seems strange that this little fish, actually swarming in the locality referred to, and in the near vicinity of a city of 45,000 people, should have escaped notice so long. It was probably mistaken for a tiny stickleback, which it somewhat resembles.

Prof. Mitchill first described the species (*vide* Trans. Lit. and Phil. Society, I. 430, 1815), and Gill includes it in his "Catalogue of Fishes of the East Coast of North America," Washington, 1873, assigning its range from New Brunswick to Florida. It would seem then that its occurrence in our waters was either known to this author, or more likely inferred, by a projection of the typical fauna of the neighbouring American coast waters to its natural and geographical limit, namely, the head of the Bay of Fundy and southern coast of Nova Scotia (*vide*

"Catalogue of the Fishes of the East Coast of North America," by T. H. Gill, p. 14, note, Washington, 1873).

Scores of specimens were measured, and the maximum length found to be one and one-half inches — a little above half the length they are said to attain farther south. Moreover, two well-defined arrangements of the dorsal spines were noticed, a regular and an irregular alternation; the former having the three free spines respectively alternate in direction, the first pointing to the left; the latter with the first pointing to the *right*, the remaining *two* to the left. Hence the direction of the first spine seems to determine the kind of alternation of the spines themselves. About eighty per cent. of a very large number showed these arrangements in nearly equal proportion; the remaining twenty per cent. fell equally under similar arrangements reversed. This fact appears to have escaped the notice of the writers referred to above, the irregular one being the arrangement of their descriptions.

Fundulus nigrofasciatus Le Sueur. Killifish.

This little cyprinodont is, like the last, an inhabitant of brackish ponds, and among the smallest of the thirteen members of its genus frequenting the coastal and fluviatile waters of eastern North America, being barely two and a half inches in length. It is very tenacious of life, and while natural to salt water can endure a long residence in the fresh element. The writer kept two taken in the mouth of Little River, St. John Co., for seven months in a globe jar in fresh water; and except a slight falling off in condition, due to the want of proper food, they retained their usual energy. It would not then be surprising did further investigation disclose that the genus is also represented by fresh-water, or, at

least, anadromous species in our province.* Indeed the Funduli of North America divide themselves naturally into two groups, one with six branchiostegal rays and confined to brackish or salt water; the other with five such rays and generally frequenting rivers and lakes, being very closely related to, if at all generically different from *Zygonectes*, the species of which, multiplied beyond all reason, are residents of fresh water.

Fundulus heteroclitus L. Mummichog. Salt water Minnow.

This species is rather common in the mouths of rivers in the northern part of the province. It is closely related to the last, from which it differs chiefly in being longer and stouter, the head heavier, thicker and flatter, the oviduct extending nearly to the end of the first anal ray; the under parts, including ventral and anal fins, pale orange instead of white: the females nearly plain, not having, when mature, the narrow black vertical bars characteristic of the former species: no golden spot at front of dorsal and caudal, as in the last form, in life.

Fundulus fasciatus, or the striped Killifish, of Perley's list, is hard to identify, owing to the endless multiplicity of terms and confused nomenclature employed in designating the various species and varieties of this genus. In the very brief description given, he refers to its sides "being of a brassy yellow, tinged with green . . . and two to five longitudinal stripes." Now these characters are said to be peculiar to *F. majalis* (Walb.) Gill; but

* Several months after the above was written the author took *F. diaphanus* in French Lake. (See list.) A short description may be here appended: Posteriorly the body is compressed, but in large specimens round and heavy anteriorly. Small examples are generally slender. Head quite flat above. General colour olivaceous with dark spots on the back, sides with from ten to twenty dark vertical bars, after the manner of *F. nigrofasciatus*. Fin formula: D. 13, A. 11; about thirty-eight rows of scales on the side. Length of largest specimens five inches. It seems to be generally distributed on the lower St. John and its affluents.

the latter is among the largest cyprinodonts, being from five to six inches long, whereas Mr. Perley gives the length from one to three. American writers assign the range of the latter from Cape Cod to Florida; so its occurrence in the Bay of Fundy is improbable.

The Funduli feed upon minute organisms, and are themselves preyed upon by tomcods, sculpins, and trout. In the northern streams the latter are very partial to them, which fact the angler turns to advantage: for the little dainty, hooked through the dorsal fin and struggling at the end of a long line, is too great a temptation for the voracious sea-run trout. When the latter in vast schools enter the river at high tide, and spread out over the submerged flats, the little Funduli are greedily devoured; and were it not for their cleverness in darting into the oozy mud few would escape. This annual drain accounts for their comparative scarcity in places well conditioned to support them in greater numbers.

Murænoides gunnellus L. Butter Fish.

This shore Blenny is said by Prof. Gill to range from Nova Scotia to Cape Hatteras, and Dr. Adams includes it in his list on the former's authority; but as there is no previous record of its actual occurrence in our provincial coast waters, a more extended notice of its form and habits may now be allowable.

The body is long, narrow, and strap-like, bulging a little in the ventral region, and tapering uniformly towards the tail. Head small, short, compressed, very narrow on top. Occipit flattened, profile suddenly decurving towards snout. Mouth small, oblique, with lower jaw projecting. Teeth in a single row on jaws, except near symphysis; a little patch on the vomer. Gill membranes united, free from the isthmus. Dorsal fin low, extending from near nape to base of caudal, with

which it is more or less confluent; all its rays spinous. Anal also confluent with tail, the junction in both cases being marked by a depression. Pectorals short. Ventrals thoracic, rudimentary, composed of one spine and one ray. Coloration: olive above; yellowish below; sides with obscure dark bars. Twelve black ocellated spots disposed quite regularly on base of dorsal. Head eight in body. Depth seven. Fin formula: D. LXXVIII. A. II, 36—38. V. I, 1. Length seven inches.

The above description is taken from two or three of the larger of a number of specimens the writer procured from St. John harbour, in September, 1893. Smaller specimens are brown above, with a dark vertical bar under the eye, and dorsal spots oblong. This fish is said to attain a length of twelve inches. They live in shallow water, gliding among the rocks and seaweed, for which movements their thin eel-shaped and slippery bodies are admirably suited. They seldom retire with the tide, but lie concealed in their usual haunts. Young shell-fish, worms, shrimps, and other crustaceans form their chief food. The species occurs on both sides of the Atlantic.

Stromateus triacanthus Peck. Harvest Fish. Dollar Fish.

This species is quite common on the southern coast of Nova Scotia, and cannot be said to be rare in St. John harbour, where some are taken every autumn in the weirs. It is a scombroid fish, with body flat, thin and ovate, the caudal peduncle being short and slender. The dorsal and ventral outlines are about equally arched. Head short and compressed. Mouth small, with blunt snout, and maxillary not reaching the eye. Teeth minute, weak, on jaws only. Gill membranes not united, free from the isthmus. Lateral line concurrent with the back, and a rudimentary one with the ventral outline.

Dorsal fin long, reaching nearly to caudal, and with a series of pores near the base. Anal fin similar. A few feeble spines, generally three, in front of each. Pectorals long. Colour: bluish above, below white, with silvery reflection. Head four, depth two and a half. The fin formula is, D. III, 44. A. III, 38. Length six inches. A specimen in possession of Wm. M. McLean, St. John, furnished the above description. As is the case with the Sea Raven, *H. Americanus* Cuv. and Val., full-grown Dollar Fish are seldom seen in St. John harbour. They are said to attain the length of ten inches, and to be very palatable pan-fish.

Scomberesox saurus Walbaum. Bill Fish. Saury.

This little pelagic fish is exceedingly rare on our coast. The writer is not aware that it was ever observed in the Bay of Fundy*; and but one instance of its occurrence on the Gulf Shore has come to his notice, when several years ago a specimen was taken on the northern side of Miramichi Bay and sent to the writer by Dr. A. C. Smith, Inspector of Leprosy, Newcastle. It was mounted, but subsequently lost. The body was smelt-like, the scales too, being small, and deciduous. Dorsal outline but little curved. Head moderate, compressed so as to be very narrow below. Jaws prolonged into a slender beak, quite as long as the rest of the head, the lower jaw being the longer. Dorsal opposite anal, and both somewhat broken up into finlets posteriorly. Caudal deeply forked. Head three and a half. Depth eight and a half. D. 9, VI. A. 12, V. Length nine inches.

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*The author has since learned that Dr. Bailey, of the University of N. B., has one from the vicinity of St. Stephen, Bay of Fundy. See list.

Specimens eighteen inches long are reported by various authors. At sea, it is said to accompany schools of mackerel, and old fishermen call it the "Mackerel Guide."

Clupea aestivalis Mitchill. Blue-Back. Summer Gaspereau.

In habits and a few points of structure this fish differs from the common alewife, and is now regarded as a distinct though closely allied species. The eyes are smaller, and the fins not so well developed. The peritoneum is black. The average size is much smaller than the spring gaspereau. They enter fresh water late in June and ascend rivers to spawn ; but do not frequent small streams, ponds, and shallow lakes as the ordinary alewife does, seeming to prefer the lower courses of rivers for that purpose. Although very fat and delicious as a pan fish, few of them are caught and cured. Their range is co-extensive with that of the larger spring species, which has led many to look upon them as the young of that variety.

CATALOGUE OF THE MARINE AND FRESH-WATER FISHES OF NEW BRUNSWICK.

BY PHILIP COX, A. B., B. Sc., PH. D

The following list is based on a "Descriptive Catalogue of the Fishes of New Brunswick and Nova Scotia," by Moses H. Perley, 1852, and a "List of the Chief Marine and Fresh-water Fishes of New Brunswick" by Dr. A. L. Adams, Field and Forest Rambles, London, 1873, to which are added a number of species since identified by the writer and others as new to the province. Both the lists were critically examined and doubtful species removed; but the writer does not wish to be understood as having examined *all* the forms included, for a dozen or more have not come under his immediate observation; yet the credibility of the witnesses and probability of the occurrence of these species within the limits of provincial waters, as inferred from their well-known range, fully warrant their retention in the list.

The more modern nomenclature, founded on priority of use and the better understood relations of families and genera, has been adopted; and, as the result, the classification is essentially that of Jordan and Gilbert, based on the views of Gill and Cope. (*vide* "Synopsis of the Fishes of North America," by D. S. Jordan and C. H. Gilbert. Bulletin No. 16, Smithsonian Institution, Washington, 1882).

Out of respect to the memory of the pioneer ichthyologist of the province, the writer, in assigning localities

and ranges, quotes from Moses H. Perley. It is only when these limits seem too restricted for a provincial list he departs from the rule. The technical name used by the same author is also given as a second designation.

Family I.— PETROMYZONTIDÆ.

GENUS 1. PETROMYZON Linnæus.

Species 1. P. marinus L., **P. Americanus** Storer. *The Lamprey.*

"Atlantic coast, ascending rivers to spawn."

Family II.— SPINACIDÆ.

2. SQUALUS Linnæus.

2. **S. acanthias** L. *Spinous Dog-fish, Picked Dog-fish.*
"Atlantic coast." Rare on northern shore.

Family III.— ALOPIIDÆ.

3. ALOPIAS Rafinesque.

3. **A. vulpes** Bonaparte. **Carcharias vulpes** Cuvier. *Thresher Shark. Swingle-tail.*
"Cumberland Bay and Bay des Chaleurs."

Family IV.— CETORHINIDÆ.

4. CETORHINUS Blainville.

4. **C. maximus** L. *Basking Shark.*
"Musquash Harbour." *Selachus maximus.* Adams.

Family V.— RAIIDÆ.

5. RAIA Linnæus.

5. **R. erinacea** Mitchill. *Little Skate. Hedge-hog Ray.*
"North Head, Grand Manan."
Gulf of St. Lawrence Coast.

6. **R. lævis** Mitchill. *The Skate. Barndoor Skate.*
"Everywhere on the coast of New Brunswick."

Family VI.— ACIPENSERIDÆ.

6. **ACIPENSER** Linnæus.

7. **A. sturio** (variety **oxyrinchus**) L. Sturgeon.
"Ascending large rivers from the sea."

Family VII.— SILURIDÆ.

7. **AMIURUS** Rafinesque.

8. **A. catus** Gill. **Pimelodus catus** LeSueur.
Horned Pout. Catfish.
"In all ponds and streams where the Yellow and White Perch are taken."

Family VIII.— CATOSTOMIDÆ.

8. **CATOSTOMUS** LeSueur.

9. **C. commersoni** Jordan. **C. communis** LeSueur.
Common Sucker. Brook Sucker.
"In all rivers and streams."

10. **C. longirostris** LeSueur. *Long-nosed Sucker.*
"Eastern chain of Schoodic Lakes." Adams.
Madawaska and Upper St. John.

9. **ERIMYZON** Jordan.

11. **E. succtta** Jordan. *Chub Sucker.*
Moxostomus oblongus (Gunther) Adams. (No locality.)
Small tributaries of Lower St. John; rare.

Family IX.— CYPRINIDÆ.

10. **CHROSOMUS** Rafinesque.

12. **C. erythrogaster** Agassiz. *Red-bellied Dace.*
Clear Lake, Lepreaux.

11. **MINNILUS** Rafinesque.

13. **M. cornutus** Mitchill. **Leuciscus cornutus** Gunther.
The Red-fin.
"Swift and limpid streams."

12. RHINICHTHYS Agassiz.

14. R. atronasus (Mitch.) Agassiz. **Leuciscus atronasus.**
Black-nosed Dace. Brook Minnow.
"In almost every brook."

13. COUESIUS Jordan.

15. C. prosthemius (Cope) Jordan.
Plentiful in Loch Lomond, near St. John. A probable variety in Spruce Lake.

15. C. plumbeus Agassiz.
Madawaska and Upper St. John.

14. SEMOTILUS Raf.

17. S. corporalis Mitchill. **Leuciscus cephalus.**
The Chub. Horned Dace.
"Every river and stream."

18. S. bullaris (Raf.) Jordan. **Leuciscus pulchellus** *et* **argenteus** Storer. *Roach Dace. Silver Chub.*
"In swift water, eddies, and pools."

15. PHOXINUS Agassiz.

19. P. neogæus Cope. *Minnow.*
Pond in Maugerville, Garnett's Lake and Dark Lake, St. John County, and a pond near Anagance, Kings Co.

16. NOTEMIGONUS Raf.

20. N. chrysoleucus Mitchill. **Leuciscus chrysoleucus.**
Golden Shiner. Yellow Shiner.
"Near Hampton Ferry." French Lake and adjacent ponds and streams, Sunbury; Belleisle; and Peabody Lake, Northumberland.

Family X.—CLUPEIDÆ.

17. CLUPEA Linn.

21. **C. harengus** Linn. **C. elongata** LeS. *Common Herring.*
"Caught on the shores every month of the year."

22. **C. mediocris** Mitchill. **Alosa mattowacca.**
Full Herring. Hickory Shad.
"Near Campobello."

23. **C. vernalis** Mitchill. **Alosa tyrannus.**
Alewife. Spring Gaspereau.
"Bay of Fundy and Miramichi Bay."

24. **C. æstivalis** Mitchill. *Blue Back. Summer Gaspereau.*
Co-extensive in range with the latter species, but entering rivers later in the season.

25. **C. sapidissima** Wilson. **Alosa sapidissima.**
Common Shad.
"Bay of Fundy and Miramichi Bay." Occasional in Baie des Chaleurs.

18. BREVOORTIA Gill.

26. **B. tyrannus** Goode. **Alosa menhaden.**
Menhaden. Mossbunker.
"Harbour of St. John."

Family XI.—SALMONIDÆ.

19. MALLOTUS Cuvier.

27. **M. villosus** Cuv. *Capelin.*
"Never ranging further south than the shores of New Brunswick."

20. OSMERUS Linnæus.

28. **O. mordax** Mitchill. **O. viridescens.** *The Smelt.*
"Abounds in New Brunswick." "Land-locked in many lakes." Adams.

21. **COREGONUS** Linnæus.

29. **C. labradoricus** Richardson. **C. albus.**
White-fish. Gizzard Fish.
"Madawaska River, Eagle, St. Francis and Grand Lakes, and Lower St. John." Upper Restigouche River.

30. **C. quadrilateralis** Richardson. *Round Whitefish.*
Madawaska and Upper St. John.

22. **SALMO** Linnæus.

31. **S. salar** Linn. *Atlantic Salmon.*
"Bay of Fundy and Gulf of St. Lawrence." Land-locked in Loch Lomond, Sciff Lake and Musquash Lake, becoming the winninnish of authors.

23. **SALVELINUS** Richardson.

32. **S. namaycush** Walbaum. **Salmo ferox.**
Togue. Tuladi.
"Found in all the large lakes of New Brunswick, including the Miramichi Lake and Loch Lomond."
The author was misled regarding its occurrence in Miramichi Lake. It is not found in the river and lake systems between the Restigouche and St. John. No other record of its presence in Loch Lomond is known. Was the winninnish mistaken for this fish? States Brook Lake, Restigouche.

33. **S. fontinalis** Mitchill. **Salmo fontinalis** *et* **trutta.**
"Nearly every lake and Stream." Anadromous specimens constitute the S. trutta of Perley's list.

Family XII.—CYPRINODONTIDÆ.

24. **FUNDULUS** Lacépède.

34. **F. diaphanus** LeS. *Spring Minnow.*
French and Grand Lakes, Sunbury and Queens Counties; Belleisle and St. John River.

35. **F. nigrofasciatus** (LeS.) Cuv. and Val. *Killifish.*
Mouth of Little River, St John.

36. **F. heteroclitus** Linn. **F. fasciatus?**
Salt-water Minnow. Killifish.
"In salt-water creeks along the coast generally."

Family XIII.— ESOCIDÆ.

25. ESOX Linn.

37. **E. reticulatus** LeS. *Green Pickerel.*
"Not hitherto appeared in any of our waters, although introduced into head-waters of St. Croix." Adams.
Quite common on Lower St. John and its affluents.

Family XIV.— ANGUILLIDÆ.

26. ANGUILLA Thunberg.

38. **A. rostrata** (LeS.) DeKay. **A. vulgaris.** *Common Eel.*
"Taken in every situation it can reach." Does not occur above the Grand Falls, St. John River Albinoes sometimes met with.

27. CONGER Cuvier.

39. **C. niger** (Risso) Jor. and Gilb. **Anguilla oceanica.** *Conger Eel.*
"A specimen taken in Pokemouche Gully in October, 1849."

Family XV.— SCOMBERESOCIDÆ.

28. SCOMBERESOX Lac.

40. **S. saurus** Walbaum. *Bill Fish.*
Bay of Fundy, Dr. Bailey. Miramichi Bay, Dr. A. C. Smith.

Family XVI.— GASTEROSTEIDÆ.

29. GASTEROSTEUS Linn.

41. **G. pungitius** L. **G. occidentalis,** *Many-spined Stickleback.*
"Plentiful, spawning in July." Adams.

42. **G. inconstans** Kirtland. *Five-spined Stickleback.*
Not uncommon on the Lower St. John.

13. **G. aculeatus** Linn. **G. biaculeatus.**
Two-spined Stickleback.
"In the estuaries of rivers and in those creeks to which the sea has access."
Quite common in lakes, and on Upper St. John, Madawaska, and Restigouche.

30. APELTES DeKay.

44. **A. quadracus** (Mitchill) Brevoort.
Brackish creeks and ponds about mouth of Little River, St. John.

Family XVII.—AMMODYTIDÆ.

31. AMMODYTES Linn.

45. **A. americanus** DeKay. *Sand Launce. Sand Eel.*
"Everywhere on the coast." **A. tobianus,** Adams.

Family XVIII.—XIPHIIDÆ.

32. XIPHIAS Linnæus.

46. **X. gladius** L. *Sword-fish.*
"Seen occasionally off the coast of the Bay of Fundy."

Family XIX.—SCOMBRIDÆ.

33. SCOMBER Linnæus.

47. **S. scombrus** Linn. *Common Mackerel.*
"Caught in great quantities on the northern coasts of New Brunswick."

48. **S. pneumatophorus** De la Roche. **S. grex.**
Easter Mackerel. Tinker Mackerel.
"Found everywhere."

34. ORCYNUS Cuvier.

49. **O. thynnus** (Linn.) Poey. **Thynnus vulgaris.**
"Coast of North America, as far south as New York."
Occasional in Baie des Chaleurs.

Family XX.—STROMATEIDÆ.

35. **STROMATEUS** Linnæus.

50. S. triacanthus Peck. *Harvest Fish. Dollar Fish.*
Not uncommon in autumn on Bay of Fundy coast.

Family XXI.—CENTRARCHIDÆ.

36. **LEPOMIS** Raf.

51. L. auritus (Linn.) Raf. **Pomotis appendix** Storer.
Long-eared Sun-fish.
Dr. Adams assigns no locality. Probably the St. Croix waters, as the species occurs in Maine.

52. L. gibbosus Linn. **Pomotis vulgaris.**
Sun-fish. Pond-fish.
"All the British Provinces." Not known on the St. John above the Grand Falls.

37. **MICROPTERUS** Lac.

53. M. dolomieu Lac. *Small-Mouthed Black Bass.*
Introduced lately into Spruce Lake and other lacustrine waters of the province.

Family XXII.—PERCIDÆ.

38. **PERCA** Linnæus.

54. P. americanus Schranck. **P. flavescens.** *Yellow Perch.*
"Common in almost all the inland waters."
"Spawns early in May." Adams.

Family XXIII.—SERRANIDÆ.

39. **ROCCUS** Mitchill.

55. R. lineatus (Bloch) Gill. **Labrax lineatus.** *Striped Bass.*
"Found on the sea coast, ascending fresh-water streams to breed in spring and for shelter during winter."

56. R. chrysops (Raf.) Gill. **Labrax albidus.**
White Bass. White Lake-Bass.
"Two specimens from Lake Oromocto, one of the headquarters of the Magaguadavic River." Adams.
The only record known to the writer east of the great lakes. An interesting note.

57. R. americanus (Gmel.) Jordan and Gilbert. **Labrax pallidus.** *White Perch.*
"Lakes and streams connected with the River St. John."
"Widely distributed." Adams. Rare in northern waters.

Family XXIV.— SPARIDÆ.

40. DIPLODUS Rafinesque.

58. D. probatocephalus (Walb.) Jor. and Gilb. *Sheepshead.*
Occasional in St. John harbour.

Family XXV.— LABRIDÆ.

41. CTENOLABRUS Cuv. and Val.

59. C. adspersus (Walb.) Goode. **C. cœruleus.**
Sea Perch. Cunner.
"Bay of Fundy." Coast of Gulf of St. Lawrence.

42. TAUTOGA Mitchill.

60. T. onitis (Linn.) Günther. **T. americana.**
Tautog. Black-fish.
"Bay of Fundy."

Family XXVI.— SCORPÆNIDÆ.

43. SEBASTES Cuvier.

61. S. marinus (Linn.) Lütken. **S. norvegicus.**
Rose-fish. Norway Haddock.
"Bay of Fundy, east of the harbour of St. John."

Family XXVII.— COTTIDÆ.

44. **HEMITRIPTERUS** Cuvier.

62. **H. americanus** (Gmelin) Cuv. and Val. *Sea Raven.*
St. John Harbour, Tracadie and Miramichi Bay.

45. **URANIDEA** DeKay.

63. **U. richardsoni** Agassiz. *Miller's Thumb. Blob.*
Mill Cove Stream, Northumberland County, and Green River, Madawaska.

64. **U. boleoides** (Girard) Jordan. *Miller's Thumb.*
Restigouche, affluents of lower Miramichi, and Green River, Madawaska.

65. **U. formosa** Girard. *Miller's Thumb.*
Madawaska River

66. **U. gracilis** (Haeckel) Putnam. *Miller's Thumb.*
Green River. Associated with **U. richardsoni** and **U. boleoides.**

46. **COTTUS** Linnæus.

67. **C. octodecimspinosus** Mitchill. **C. virginianus.**
Common Bull-head. Long-spined Sculpin.
"Very numerous on all the fishing grounds."

68. **C. scorpius** (var. **grœnlandicus**) Cuv. and Val.
The Greenland Bull-head.
"On all the fishing grounds." The typical **scorpius** is also found in the Miramichi Bay.

69. **C. labradoricus** (Girard) Gunther. *Labrador Sculpin.*
(No locality). Adams.

Family XXVIII.— TRIGLIDÆ.

47. **CEPHALACANTHUS** Lac.

70. **C. spinarella** (Linn.) Lac. **Dactylopterus volitans.**
Sea Swallow.
(No locality). Adams.

Family XXIX.—CYCLOPTERIDÆ.

48. CYCLOPTERUS Linnæus.

71. **C. lumpus** Linn. **Lumpus vulgaris.**
Lump Sucker. Lump Fish.
"Grand Manan." St. John harbour and Miramichi Bay.

Family XXX.—BLENNIIDÆ.

49. MURÆNOIDES Lac.

72. **M. gunnellus** (L.) Gill. *Butter-fish.*
St. John harbour and coast of Bay of Fundy.

50. EUMESOGRAMMUS Gill.

73. **E. subbifurcatus** (Storer) Gill. **Pholis subbifurcatus.**
Radiated Shanny.
(No locality). Adams.

51. CRYPTOCANTHODES Storer.

74. **C. maculatus** Storer. *Wrymouth.*
St. John harbor.

52. ANARRHICAS Linnæus.

75. **A. lupus** Linn. *Wolf-fish.*
"Near Grand Manan and Campobello."
A. vomerinus Adams.

Family XXXI.—LYCODIDÆ.

53. ZOARCES Cuvier.

76. **Z. anguillaris** (Peck) Storer. *Eel Pout. Mother-of-Eels.*
(No locality). Adams.
Abundant in Miramichi Bay, where both varieties, **Z. anguillaris** and **ciliatus** Mitchill, occur.

Family XXXII.—GADIDÆ.

54. PHYCIS Bloch.

77. **P. chuss** (Walb.) Gill. **P. americanus.**
Squirrel Hake. American Hake.
"On muddy bottoms in the Bay of Fundy." Rare in Miramichi Bay.

55. LOTA Cuvier.

78. **L. maculosa** (LeS.) Cuv. and Val. *Burbot. Cusk.*
"River St. John, Eagle and St Francis Lakes." Restigouche waters and Lake Utopia.

56. BROSMIUS Cuvier.

79. **B. brosme** (Müller) White. **B. vulgaris.** *Cusk. Torsk.*
"In Bay of Fundy. Not abundant." Occasional on the Miramichi coast.

57. GADUS Linnæus.

80. **G. æglifinis** Linn. **Morrhua æglifinis.** *Haddock.*
"Campobello." (No locality). Adams.

81. **G. callarias** Linn. **Morrhua vulgaris.** *Common Codfish.*
"Grand Manan, Northumberland Straits." More or less common on the whole coast.

82. **G. tomcod** Walbaum. **Morrhua pruinosa.**
Tomcod. Frost Fish.
"Taken on shores throughout the year." Ascends rivers in January to spawn.

83. **G. virens** Linn. **Merlangus carbonarius.** *Pollock.*
"Bay of Fundy."

58. MERLUCIUS Raf.

84. **M. bilinearis** Mitchill) Gill. **M. albidus.** *Silver Hake.*
"Grand Manan." Occasional in St. John harbor.

Family XXXIII.— PLEURONETCIDÆ.

59. HIPPOGLOSSUS Cuvier.

85. H. vulgaris Fleming. *Halibut.*
"Bay of Fundy." Rare on northern coast.

60. PLEURONECTES Linnæus.

86. P. ferrugineus (Storer) Jor. and Gilb. **Platessa limanda.** *Common Dab. Sand Dab.*
"Everywhere on the coast."

87. P. americanus Walbaum. **Platessa plana.** *Winter Flounders.*
"Everywhere on the coast."

Family XXXIV.— LOPHIIDÆ.

61. LOPHIUS Linnæus.

88. L piscatorius Linn. **L. americanus.** *Angler. Fishing Frog.*
"Bay of Fundy." Miramichi Bay.

Family XXXV.— ORTHAGORISCIDÆ.

6. MOLA Cuvier.

89. M. rotunda Cuvier. *Sun-fish.*
Bathurst harbour. St. John harbour.

ADDENDUM.

90. Raia radiata Donovan. *Starry Ray.*
St. Martins, Bay of Fundy.

ARTICLE III.

THE VOLCANIC ROCKS OF THE MARITIME PROVINCES OF CANADA.

By W. D. Matthew, Ph. D.

Read May 7, 1895.

In discussing the volcanic rocks of the Atlantic coast it is convenient in several respects to consider first those of the Maritime Provinces. For—

1. They occur here in as great, or greater abundance than in any of the areas to the south-west of them.

2. They have been recognized as such from very early times, and their extensive occurrence has never been questioned.

3. They are comparatively little altered — less so than many of those in the United States.

4. There is no question as to the age of a large part of them.

It may be as well to outline briefly the general geological structure of New Brunswick in order to make clear the arrangement of the volcanic rocks. The province is divided into three areas of very different geologic features. To the south, fronting on the Bay of Fundy, lies a rugged and hilly region of very complicated geology, consisting largely of north-east and south-west ridges of metamorphic rocks, with the valleys between partly filled by later sediments. To the north of this lies a great triangular area of carboniferous rocks, flat-lying, seldom over

three hundred feet in height, fronting on the Gulf of St. Lawrence. North-west of this, and separated by a broad band of metamorphic and intrusive rocks, lies the great Silurian area, mostly high, rolling country, underlain by slaty rocks which are much upturned, but not excessively altered. The division of the province into Southern, Central, and Northern or North-western, is hence a very convenient one.

The formations represented range from pre-Cambrian to Triassic. The pre-Cambrian consists of the highly metamorphic gneissic series, which has been compared to the Laurentian; and the largely volcanic series compared to the Huronian. The Cambrian slates occupy parts of some of the valleys of southern New Brunswick, but are not important areally. The Ordovician or Cambrosilurian consists of much altered slates and sandstones flanking the granitic and pre-Cambrian areas. The Silurian occupies the north-west part of the province, and is less altered than the Ordovician, and very generally fossiliferous. The Devonian consists of slates and sandstones, occupying various small areas both in northern and southern New Brunswick. Along with all the previously formed rocks these have been much folded and upturned and considerably metamorphosed by the mountain-making processes which occurred at its close, and which were far more important in the Maritime Provinces than further to the south-west. The red sub-carboniferous rocks are never much metamorphosed and very generally little upturned, while the grey carboniferous sandstones are usually almost flat-lying. Two or three very small areas of red Triassic sandstone occur along the northern shore of the Bay of Fundy, and are the youngest consolidated strata found in the province.

As far back as 1838 Dr. A. Gesner, in the reports of the Provincial Survey, speaks of the great quantities of volcanic rock in New Brunswick, and continually emphasizes the importance of igneous outbursts in the southern part of the province. He appears to have considered these eruptions as geologically recent, for he connects them with the earthquakes and changes of level within historic times, and considers that "the lofty mountain, the vertical cliff, the foaming cataract, the rude outline, and other sublime features of the district," are to be attributed "to the earthquake and the volcano." He figures in the second report some supposed volcanic cones, of remarkable perfection, considering that they are of pre-Cambrian age. However, his general ideas as to the character of the rocks were correct enough, considering the time of writing.

The Dominion Survey from 1868 to 1888 (?) confirmed the early views as to the character of these rocks, showing the eruptives to be very widely distributed through the province, and to be in part of very early age. It was accompanied by accurate maps constructed on a scale of four miles to the inch.

From the pre-Cambrian down to the Triassic, New Brunswick must have been the seat of great, though intermittent, volcanic activity. Rocks known to be eruptive cover a considerable part of the superficial area, and their thickness is locally enormous. It is probable that they underlie a large area now covered by sedimentary strata.

The oldest rocks in the province are the highly metamorphic gneisses, schists, and limestones, forming the so-called Laurentian. These are entirely sedimentary, showing no trace of contemporaneous volcanic activity. With them are associated large areas of granite, some of which are certainly, and many more probably, intrusive.

Over the Laurentian are great thicknesses of beds composed of surface volcanic rocks, which have been divided into three or four groups in the southern part of the province, but which are conveniently classed together as Huronian, if the term be used in its broader sense, or, if this be disallowed, must be simply called pre-Cambrian. These form the greater part of the southern metamorphic hills, and occur in small patches north of these. The high broken country about the headwaters of the Tobique, Nepisiguit and North-west Miramichi, is composed of pre-Cambrian rocks, largely eruptive, and intrusive granite.

These volcanic rocks are known for the most part only through field descriptions. They are hard, fine-grained flinty rocks, mostly red or dark colored; some time, though not generally, schistose; and not always recognizable as of igneous origin. Those from a part of the southern metamorphic hills have been studied by the aid of the microscope and are then seen to show all the characteristic structures of volcanic products in great perfection. They evidently were once precisely like the lavas and ash-rocks of modern times. The changes they have undergone are mostly limited to the devitrification of the glassy parts and the partial or complete recrystallization of some of the minerals.

The deep-seated crystalline facies of these effusives is not well known. They may perhaps be the surface equivalents of some of the granites and other intrusives in the Laurentian rocks; but this remains to be proved. Although many instances are recorded by the New Brunswick and Nova Scotia geologists of transitions from granite into felsite, yet none can be taken as satisfactory without the support of thin sections and chemical analyses to prove their identity in composition, and a careful study of the progressive gradations from one to the other.

The general character of the pre-Cambrian volcanics that I have seen is tolerably uniform. They are mostly either feldsparporphyry or diabase, or approach closely to one of these two types. Strongly quartzose porphyries are not common, nor are intermediate rocks of the andesite type, while olivine rocks have not been recognized among the effusives. A soda-granite occurs among the Huronian rocks near Upham, but its relations to them are doubtful.

The Huronian began in southern New Brunswick with rocks exclusively volcanic. These reached in places an enormous thickness (up to 11,000 feet in the Kingston Group at New River), but in places they thin out to a few hundred feet of fine-grained tuffs, or are entirely absent. They are covered by coarse red rocks, conglomerates and shales, which are thought to have been rapidly deposited over an area of dying volcanic activity, and have some interbedded volcanic deposits. After this followed a long period of rest while the Cambrian and Ordovician slates were being deposited. In the neighborhood of St. John there was no resumption of volcanic activity, but in the region about Passamaquoddy Bay the Silurian was again a period of igneous outbursts — of lavas and ashes, which now lie interbedded with the fossiliferous sediments, and form the more prominent hills of that neighborhood. In the northern part of the province, around the upper part of Baie Chaleur, are large areas of volcanic rocks, felsites and traps, which cut through Silurian slates, but appear to be earlier than the Devonian rocks. These effusives form high hills standing out prominently along the shore between Bathurst and Campbellton; at the latter town the Sugarloaf Mountain, rising abruptly over 1,000 feet, is composed of felsite. Smaller areas of volcanic rocks, cut the Silurian slates in other parts of the province; at Moose Mountain, east of the

St. John River, they form a conical hill over 1,000 feet in height, from which a magnificent view of the surrounding country can be obtained. The great development of igneous rocks of this period is, however, at Baie Chaleur. In connection with the Devonian of southern New Brunswick are volcanic rocks; sections of some near Point Lepreau show them to be ordinary quartz porphyries of no special interest.

Again, in the sub-Carboniferous period we find that a large amount of volcanic outpourings took place at various points along the southern margin of the central plain, and volcanic rocks appear from under the eroded millstone grit rocks at Grand Lake, within this plain. The Blue Mountains, north of the Tobique River, consist of effusive rock referred to this period. These sub-Carboniferous volcanics are felsites and traps, and have not been studied with the microscope.

Throughout the Middle and Upper Carboniferous and the Permian periods there is no trace of any volcanic activity, but the small areas of Triassic rocks occurring in New Brunswick, are associated with heavy trap dykes, and about half of the island of Grand Manan is composed of Triassic trap.

The periods of volcanic activity in New Brunswick are, then:

1. *Huronian* — Southern New Brunswick and the northern watershed.

2. *Silurian* and *Early Devonian* — Passamaquoddy Bay, Baie Chaleur, etc.

3. *Sub-Carboniferous* — borders of the central plain, Grand Lake, Blue Mountains of the Tobique.

4. *Triassic* — Quaco, Grand Manan.

In Nova Scotia the volcanic rocks are not less important than in New Brunswick. In Cape Breton is a great

development of pre-Cambrian rocks, which appear from the reports to be chiefly igneous; and considerable areas occur in Pictou county, and in the range of hills north of the Basin of Minas. A large amount of volcanic material of later age also occurs in the north-eastern part of the peninsula. From Dr. Fletcher's reports it would appear that the volcanic periods were about the same as in New Brunswick, with the addition of the Ordovician.

The Triassic traps forming the North Mountains of Nova Scotia, lying all along the southern side of the Bay of Fundy, are well known. Besides the main area there are small detached ones in the Basin of Minas. These rocks are often amygdaloidal and have a wide fame as mineral localities. The rock has been examined by Prof. V. F. Marsters and is a normal diabase, very uniform in character and very like the Triassic traps of the eastern United States.

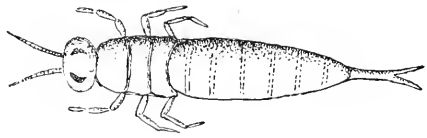
Prince Edward's Island affords no volcanic rocks.

In Newfoundland the conditions were much like those of Nova Scotia and New Brunswick. The Laurentian rocks are capped by a series, in large part volcanic. (Of the extent of later volcanics I cannot speak certainly, it is probably much the same as in Nova Scotia.)

So far, little note has been made of the intrusive granites which form so important a feature of New Brunswick and Nova Scotian geology. The main areas of these rocks in New Brunswick are considered to be of Devonian age; they are found cutting through and metamorphosing Silurian strata, while as pebbles they first appear in the conglomerates of sub-Carboniferous age. Two great bands cross the province, the one coming in from Maine north of the head of Passamaquoddy Bay, and running north-east nearly to the St. John River; the other entering at the Chiputucticook Lakes at the head

of the St. Croix River, and stretching in a number of interrupted bands nearly to the shores of Baie Chaleur. A great area flanked on each side by metamorphic slates of doubtful age, through which it has thrust itself, stretches from end to end of the Nova Scotian peninsula. Other small isolated areas are known in both provinces, but none at all comparable in size to those mentioned. These granites seem to have come to the surface during the great upturning that closed the Devonian in the Maritime Provinces, and which metamorphosed and tilted to a greater or less extent all the pre-Carboniferous strata.

The Maritime Provinces affords a great field for petrographic study of igneous rocks and one in which little has been done. The question as to the individual succession of the different kinds of rocks in each volcanic period, their centres of distribution, and the connection of the surface volcanics with the intrusive masses are as yet almost untouched, and although the unsettled and wooded character of much of the region would hinder the working out of these problems, yet a careful study would no doubt be well repaid. It is to be hoped that much will yet be done in this almost untrodden field.



PODURITES SALTATOR.

A fossil insect (Springtail) of the Little River Group—magnified and restored.

APPENDIX.

Report on the Summer Camp at French Lake.

(Held August, 1893.)

The principal object of the visit to this district was the study of the remains of the Stone age, which from information we had known were to be found there. August was chosen as the best time to visit this lake, as during this month the St. John river is usually at its lowest stage, and the shallows along the shores are then above the surface of the water, or near to it.

Topography and Geological Conditions.

French Lake is the uppermost of three considerable sheets of water that lie in the lowest part of the central plain of New Brunswick. These lakes are not individually in direct connection with the St. John river at the ordinary stage of that stream; for while the river traverses this depressed part of the central plain in which the lakes are situated, it has built up for itself on each side, banks of alluvium, which bound its channel, and shut it off from the lakes.

As a consequence, the outlet of the lakes is by a narrow, deep channel (the Jemseg) which enters the St. John several miles below the last of the chain of lakes (Grand Lake). Similar deep passages, locally called "thoroughfares," connect the middle lake (Maquapit) which the other two.

The current is not always downward through these passages, for when the river St. John rises, owing to rains in the upper valleys of that stream, the water runs backward in the thoroughfares, and the lakes become reservoirs for the storage of the surplus waters of the river. The thoroughfares being the only means of connection between the lakes, and with the river at its ordinary stage, and as also giving access to the numerous creeks and shallows around the lakes, swarm with fish at certain seasons of the year. In former years, these passages were black with gaspereaux and shad, pressing forward into the lakes to spawn in the shallows, and even now fish abound in them.

A people capable of taking these fish by spear, net or line, would find an easy means of subsistence on the shores of these

creeks and thoroughfares; and at the more commanding spots one might naturally look for indications of occupancy by a rude people. Such indications are not wanting, but they did not occur in the way anticipated from the exploration of village sites along the Bay of Fundy. There, when the sites were undisturbed by the plow, one had no difficulty in seeing the situation and extent of the village, nor in tracing the outlines of each particular hut-bottom, nor noting the place of the sleeping berths, the position of the door, nor in counting, if necessary, the hearth stones.

But on the shores of these inland sheets of water, no such evidence of the habits of the former savage inhabitants could be found. At the points of land along the shores of the lakes, at the entrances of the thoroughfares, or where creeks led into ponds in the marshes, no hut-bottoms were found, but proofs of the presence of man were frequent in the shape of broken pottery, flint flakes, or lost celts, arrowheads and axes. It was evident that the people who lived along these shores had means of traversing the water by canoes or otherwise, and planted their habitations where water communication was easy, and fish plentiful. But it is also clear that their shelters were of a temporary kind, and built near the water's edge.

Their mode of life in this way along the banks of the streams, explains why we find not the least trace of their habitations. These lakes, with their connecting streams and marshy borders, disappear in the spring time, for the flood of water poured out by the great tributaries of the St. John submerge all this region, and produce for the time a great inland lake extending up the valley of the St. John to Fredericton on the one hand, and the Oromocto valley on the other, covering ing about six hundred square miles of surface. It may rise above the summer level to a height of twenty feet or more, and with a wide range for the waves, would, in stormy weather, throw a surf on the shores that would soon demolish the dwellings of a rude people, and mingle even their more enduring implements and weapons, left or lost on the site of their encampment, with the pebbles and sand of the beach. Such, no doubt, was the fate of many an implement which otherwise would have remained on the surface of the ground to the present day, to bear witness to avocations of the fisherman and the hunter, pursued during the Stone age along these grass-grown shores.

These lake basins date back as far as the time of the deposition of the Champlain clays or Leda clay; and the material of the clays is that with which we are familiar as stock for the

manufacture of our bricks. A cursory glance at the map of New Brunswick would lead us to think that these lake basins were produced by the building up in their front of the alluvial deposit of the St. John; but a more intimate knowledge of their shores shows that they and the banks of the thoroughfares are to a large extent composed of Leda clay.

Furthermore, it would appear, that if a subsidence of this region is in progress, it is very slow indeed. The south-west shore of Maquapit Lake illustrates this point very clearly; for this lake is now encroaching on its low clay shores, uprooting the vegetation along its banks, and exposing in its submerged mud-flats, the roots of the former forest; these roots and their rootlets are now cased in ferrugenous pipes, hardened in the surrounding clay.

A curious relic or fragment of a former thoroughfare along the southern side of this lake is found in "Ring Creek," a semi-circular channel which has no break in its bank toward the side of the river, but has shallow outlets, at each end, to the lake. The channel of the creek within the flats at the two outlets is deep, but without any current at the present time. This demolished thoroughfare is proof of a decided encroachment of the lake upon its shores at the southern side. A similar condition of things appears to prevail along the south-west shore of Grand Lake, as flint-flakes have been found on the flats there, but no investigation was made by our party. On the shallow mud-flats on this side, both of Maquapit and Grand Lake, "flint" flakes and implements have been found; on the former lake as much as a furlong from the shore.

The facts observed indicates a very slow and gradual sinking of the land in this region, leaving the stone relics on the mud and sand at the bottom of the advancing lake; it thus encroached upon the yielding shores, and removed what traces there might be, of aboriginal camping sites.

Leading from Maquapit into French Lake are two thoroughfares of which that nearest the river is bordered by high banks of alluvium, and only at the ends shows exposed banks of Leda clay. The other thoroughfare, which is shallow, is known as the Blind thoroughfare, and shows banks of Leda clay all along its winding course.

The whole country around these lakes is of gently undulating land, diversified with low rounded hills of Boulder clay and with a few gravel ridges. Over the Boulder clay is spread a thick coating of Leda clay of a grey color, from which are washed great numbers of pellets of iron ore, which form layers as of sand along the shores of the lakes.

We have called the clay which bordered and underlies these lake basins, Leda clay, because it holds the same relation to the Boulder clay below, and the alluvial deposit of the river above, as the red Leda clay of the valleys at the coast holds to corresponding deposits along the Bay of Fundy. It should be said, however, that no trace of marine shells has been found in this clay; and it is quite possible that the basin in which the clay was deposited may have had no free communication with the ocean.

This visit to French Lake disabused us of a notion as to the relative stage of culture of the men who lived on the river, and those who inhabited the shores of the Bay of Fundy. Previously we had been inclined to allow a possible difference in the degree of artistic finish of their weapons, by the men of the Stone age occupying these districts, respectively.

Such a distinction has been claimed between the men who left the kitchen-middens on the coast of Denmark, and those who formed the tumuli of that country, and lived in its interior. It is quite evident, however, that such a distinction does not hold for the Stone-age men of the St. John river and the Bay of Fundy coast respectively, as many of the weapons gathered on the shores of the lakes which we examined, were quite as rude as those found at Bocabec.

The difference which has existed in this respect between the collections made on the river St. John and those gathered from the shell heaps on the Bay of Fundy, appears to be due to the fact that around the lakes only the tools and weapons which possessed a good finish were recognized as works of art, and collected by the ordinary observer, and the coarser implements were entirely overlooked. This is quite natural, if we observe how difficult it is to distingnish some of these rude tools from ordinary boulders and stones—such were many of the celts, hammers and scrapers which we collected.

The flaked implements showed in many cases considerable nicety of finish, and were of several patterns. The spear heads were of two principal types, one a heavy head for a stout spear, the other having a slender point, and being similar to forms which have been thought to be points of fish spears.

The arrowheads were very variable in size, and were barbed or tined, or wedged-formed at the base.

We found two types of skin scrapers which are new to the New Brunswick collections: one is of a triangular form, the pointed end of the triangle being for insertion in a handle; the second form was oblong with a rounded back and apparently equally well finished at either end; this may have been intended

for use without a handle. A novel implement found here which may have been a scraper to hold in the hand, was of the form of an ordinary bivalve shell with a bulbous swelling on each side corresponding to the umbones of such a shell. The wood scrapers were not of so definite a form as those found at Bocabec, nor did they so frequently show proofs of use as scrapers.

Knives and knife-flakes were common, and did not show unusual forms, except one scymitre-shaped example, and one larger and coarser than usual, having chipped edges.

Among the relics found there were a few axes fitted for mounting in with handles and one small war axe. Celts were numerous, but many were of the rudest kind, and evidently were boulders of suitable form which could be adapted for use with very little preparatory chipping or grinding.

At this camp eighteen persons were present, and instruction was given in archology, geology, botany and microscopy. The camp was under the management of the Secretary of the Society —S. W. Kain—and the instructors were G. F. Matthew, W. D. Matthew, and Frank Berton.

The members were greatly indebted to the late J. S. Jewett of Lakeville Corner, and his family, who extended their hospitality to the members of the Society on their arrival, and aided them in many ways during their stay. It was through Mr. Jewett's instrumentality that a public hall was placed at the disposal of the Society for lectures and class work.—G. F. M.

Report on the Summer Camp at Lepreau Basin.

(Held July 1895).

The neighborhood of Lepreau Basin affords excellent opportunities for the study of botany, marine zoology and geology, and for this reason, as well as for the unusual facilities for laboratory work and lodgings afforded to the Society through the liberality of G. K. Hanson, Esq., Collector of Customs at Lepreau, was chosen by the Council for the exploratory work of this summer. This place is accessible by means of the Shore Line Railway to Lepreau Station, whence a drive by stage of about four miles brings one to the shores of the Basin.

Lepreau Basin is a land-locked sheet of water, closed in from the sea by a gravel beach and low cliffs of sandstone. At low tide there are extensive sand flats in the basin, which are traversed by interrupted creeks and ponds, affording a refuge to the marine animals which the rising tide bring into the basin. Outside

of the basin, also, on the shore of Mace's Bay, the ledges of sandstone, laid bare at low tide, afford opportunities to collect other species, which are rare in the enclosed waters of the basin.

The headquarters of the camp were in a vacant house on a mining property owned by Mr. Hanson, near the shore of the basin. A large room served for a lecture and demonstration room, and the rest of the house gave ample accommodation for the party of members who attended the camp.

The building we used had been put up by a mining company which undertook to operate on the beds of coal which are found in the Dadoxylon sandstone. The earliest work on these beds was undertaken by Mr. Hanson at his boat landing, on the shore of the basin, where two seams appear. The company referred to above, after operating on the northernmost of these seams, transferred their works to where the seam is exposed at the edge of the bank, one hundred yards or more to the westward. Not being satisfied with the position of the pit, which, being near the shore, was subject to a heavy flow of water, the company undertook to sink a new shaft some distance back from the bank, with the intention of drifting south to the coal seam. This shaft was entirely in the red shales of the Mispec group, which are here let in behind the sandstones of the Little River group by a fault. The sinking of this shaft, the cost of new buildings, and other expenses which were incurred, crippled the company financially, so that they were unable to carry their work further, and their buildings and property have reverted to Mr. Hanson, the original owner and one of the stockholders.

Operations on these seams have been undertaken at the middle and at the eastern end of the basin by other lessees, but as these mines are beyond the limit of the district examined by our party, it is not necessary further to refer to them.

Beside the tract immediately around Lepreau Basin, our party spent a day in visiting Point Lepreau, which lies some miles to the south of the basin. In some respects very little was gained from this visit, but the members had a good opportunity of seeing the picturesque cliffs and shores around this Point and of inspecting the lighthouse at its extremity. No traces of aboriginal camping-grounds were found on the beaches, either east or west of the point. Professor Ganong found reason to think the shores around this point would prove an excellent collecting ground for those in search of marine animals and plants.

The Word "Lepreau."

Prof. W. F. Ganong has sent the following note respecting the origin of this word:

'The ultimate origin not known with certainty; but doubtless it is French of same period with "L'Etang," etc. But our word is unquestionably a lineal descendant of the Point *la Proe* of the English maps of the early part of the last century — those of Southack and others, and it can be traced all through maps of ths last century. Our Lepreau may be only an effort to restore the French form. Upon grounds both historical and philological the word should be "Lepreau" and not "Lepreaux." If the "x" is put at the end it should be written "Lespreaux," but there is no historical basis for this. I therefore think "Lepreau" should be the form used.

'Modern dictionaries give "Preau" as meaning a flat or mea dow, which is not very appropriate to the place, and we are not sure that it was the original word. Another puzzle about it is that certain French maps of 1744–55 have "Napreaux"; but earlier English ones call it "la Proe." I cannot find any meaning for the word "Napreaux," and it is possibly a misprint for something else — misprints are very common on old maps. The "x" may have some significance in explaining where the "x" in our form Lepreaux came from.'

Topography.

The district where we spent our week consists of two essentially different tracts of land separated by the main arm and outer part of Lepreau Basin.

To the north of the basin is a low lying tract extending northward to Lepreau harbor and river, diversified with alternations of heath covered clay flats, low rocky ridges with gravelly slopes clothed with straggling forest and copses; and in the wettest parts peat bogs of considerable extent.

To the south of the basin the land is higher and carries on its higher ridges tracts of hardwood forest, and on the slope toward Mace's Bay has a range of farms in a good state of cultivation, extending nearly to Point Lepreau.

Around Lepreau Basin itself there are clay flats where the soil has been turned into meadow land, but these are of no great extent.

Geological Structure.

The topographical features of this peninsula are clearly traceable to its geological conditions in past time. Running through it in a north-east direction are two axes of Laurentian rocks; one near Lepreau River, consisting of quartz-diorites and gneissic rocks; the other lying to the south of the main arm of Lepreau Basin, consisting of quartzites and limestones of the "upper series" of the Laurentian area.

Between these axes is a narrow basin extending through to the Musquash River, filled with sediments of the Little River and the Mispec groups, which have been crushed together and thrown into a number of broken synclinal, anticlinal and monoclinal folds. The great dislocations which these beds have suffered makes it difficult to trace their structure, and has detracted from the commercial value of the coal beds which they contain, and which are of exceeding interest to the naturalist on account of their unrivalled antiquity.

Resting upon both the old Laurentian sediments, and these later ones of the Little River and Mispec groups, is a series of conglomerates and sandstones, skirting the eastern shore of Mace's Bay, and extending around Point Lepreau toward Dipper Harbor. Mace's Bay is largely underlain by this series of rocks, which rises to view in Salkeld's Islands, and when the tide is low is seen to extend in wide reefs, miles away from the shore.

Owing to the calcareous cement binding these sandstones and and conglomerates together, which dissolve on exposure to the rain and weather, they waste away rapidly at the high tide line, and form a line of low cliffs facing Mace's Bay; and to the easy solution of this same calcareous cement is largely due the fertility of the farms constituting the thriving settlement along this shore.

From the attitude of the slates and sandstones of Lepreau Basin, the history of some of the dynamical movements which have affected the rocks of this district may be inferred. Thus, on the line of the main arm of Lepreau Basin there is a narrow strip of the lower carboniferous conglomerates and sandstones that has been let down among the Little River and Mispec sediments, and is boundedby sharply defined fault lines. So also on the Lepreau harbor, on the north side of the peninsula, there is a narrow belt of these same sandstones and conglomerates, lying between the rocks of the northern axis of Laurentian, and the schist and diorites on the north side of Lepreau Harbor.

The bands of softer unaltered rocks among the older sediments and igneous rocks, appear to have determined the place of

these two harbors, and so the main lines of depression of this peninsula area. Not that this condition of depression is entirely due to the softer texture of the later rocks, but there is little doubt that the lines of weakness and faulting that have been determined where these strips of the more recent sediments are let in, have continued to be lines of weakness and faulting in later ages.

The history of geological events in this district may be summarized as follows:

1. The oldest recognizable deposits are the quartzites and limestones of the "upper series" of the Laurentian area, which appear in the hills south of the basin.

2. A great break in the succession of beds then follows. This includes the time when the Coldbrook (Huronian?) and St. John groups were deposited, and so extends from pre-Cambrian to early Ordovician time both included. It also includes the later Ordovician, which appears to have been a time of continental elevation in New England and Acadia.

3. Second period of sedimentation. At this time the Little River group was deposited.

4. Folding of this group with heavy erosion, exposing the limestones and quartzites of the Laurentian.

5. Another period of sedimentation during which the Mispec group was deposited.

6. Third period of erosion, with folding and faulting of the beds, exposing again the Laurentian rocks. Great lateral pressure and partial metamorphism of all the older terrains accompanied these changes.

7. Another period of sedimentation, during which the Lower Carboniferous terrain was laid down.

8. This terrain also was uplifted and folded, but the subsequent geological changes are not exemplified by any deposits in this district until the Glacial epoch.

The organic remains collected from the sandstones, etc., at Lepreau will form the subject of a future communication.

—G. F. M.

Zoology.

The zoological results were mostly negative. Owing to the shortness of time the camp was in session, unfavorable weather and difficulty of obtaining a proper boat, no dredging was done, and exploration was confined to walks along the shore at low tide. The fauna is the usual beach fauna characteristic of this region, and nothing was observed to differentiate it from the well-known assemblage of animals about Frye's Island. It was hoped that in Lepreau basin, sheltered as it is, traces would be found of the southern forms which linger in small colonies in

sheltered spots on the shores of Acadia, and traces of which have been found on the St. Croix River. But although some search was made no trace of them was found. Lepreau Basin itself is disappointing, for it is rather barren of any forms except the economic clam; at all events this is true of mollusca and echinoderms, the two test-groups of our fauna. Star-fishes and even sea-urchins occur there hardly at all; a fact due, no doubt, to the long time the basin is empty at each tide and consequent warming of water in the pools. Much was expected also from the excursion to Point Lepreau itself, but the tides were neap and on our arrival an hour flood. But enough was seen in the tide-pools to show that this is a most promising locality, and it is earnestly commended to the attention of those members of the Society who may have opportunity to visit it. Mace's Ledges were also found extremely barren of animal life, and the forms found were of the commonest.

Visits were made to Clear Lake, a remarkable basin not much more than a quarter of a mile long, and without inlet. Locally reputed to be bottomless, an extreme depth of seventy-eight feet was found, after thorough soundings; but this is a great depth for so small a lake. On both sides of the lake are ledges belonging to the Dadoxylon sandstone, and the lake seems to occupy a gorge in them. Interesting water plants grow in the lake, including *Eriocaulon septangulare*, growing at a depth of nine feet. There are interesting biological problems connected with this plant, particularly as to how it obtains the oxygen needed in the development of its enormously long flower stalks.

The camping party spent about ten days at Lepreau Basin. The instructors were Professors W. F. Ganong and L. W. Bailey, Principal G. U. Hay and Dr. G. F. Matthew. Lectures were given in the evening on zoology, botany and geology, with excursions and class-work during the day.—W. F. G.

Report on Geology.

It may be of interest to the members of this Society to know that the Cambrian rocks of St. John have yielded several brachipods, which have thrown considerable light on the early history of this great class of the mollusca; a group of much greater importance in past time than now: but of which, nevertheless, several very ancient types have subsisted until the present time.

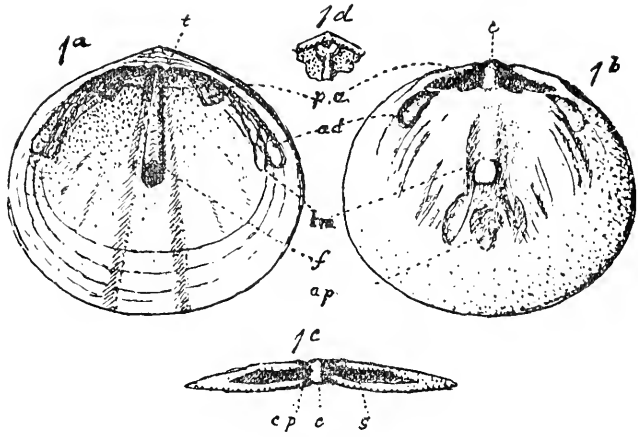
The progress which has been made of late years in the knowledge of this ancient group, has led to the suggestion of several systems of classification, looking to the incorporation of this new knowledge.

One of the latest systems of classification is that proposed by Prof. Chas. E. Beecher, which has been amplified and extended by Chas. Schuchert, and illustrated by Prof. J. M. Clarke and Miss Agnes Crane. In this system the position of the opening or passage for the byssus or thread, by which the shell was anchored, is taken as of primary importance in classification.* Thus there are the (1) Atremata, in which there is no passage through the shell for the byssus, or merely a groove in the edge of one of the valves. (2) The Neotremata in which the shell may have a perforation at various distances, from the back of the valve along the central line. (3) The Protremata, in which there is a slit at the back, more or less completely closed by a plate. (4) The Teleotremata, which belong to a period later than the Cambriam, and in which the "arms" within the shell have a calcareous support.

Some primitive and therefore, to the naturalist, highly interteresting examples of genera of the first three orders are found in the Cambrian rocks at St. John, among which may be named for the first order, *Botsfordia pulchra* (Matt.), the young of which have the form of the most primitive type of Brachiopod known; for the second order *Trematobolus insignis* (Matt.), (figured below), which unites the general characteristics of the first order with the perforated valve of the second and the articulating hinge of the third; for the third order, *Protorthis Billingsi* (Hartt), remarkable for the broad low opening in the valves, and its resemblance to the genus Orthis of later Cambrian time.

* The value of this character in the classification of the Brachiopoda was urged a good many years ago by Prof. Jas. Hall of Albany.

Fuller accounts of these and other genera of the St. John Group may be seen in the transactions of the Royal Society of Canada, in Genera of the Brachiopoda, by Jas. Hall and J. M. Clarke,* and in the Protolenus Fauna.†



TREMATOBOLUS INSIGNIS.

a. Interior of the ventral valve. *b.* Interior of the dorsal valve. *c.* Dorsal valve seen from behind. *d.* Inside of beak of ventral valve. *Notation of the muscles, etc.* *p. a.* Posterior adductor. *a. d.* Adjuster muscles *l. m.* Lateral muscles. *a. p.* Anterior depression. *c. p.* Cardinal pit. *c.* Cardinal process. *s* Hinge socket. *t.* Dentiform process of the ventral valve. *f.* Foramen. From Assize 2. Band *b*, Div. 1, St John Group at Hanford Brook, St. John County, N. B.

—G. F. M.

BOTANICAL REPORT.

The Botanical Committee report the occurrence of the following plants :

Plantago maritima, Lepreau (Hay); Gilia linearis, Gray, Lepreau (Roy Vanwart and Geo. W. Bailey); Lathyrus pratensis, L. Ledge, St. Stephen (F. A. Pickett); Comandra livida, Richardson, Lepreau; Ralfsia deusta, an addition to our Algoid flora, on rocks at low water. Entrance of Lepreau basin (W. F. Ganong). Some notes upon the plants of the peat bogs will be communicated at a future time by Prof. W. F. Ganong.

—G. U. H.

* Published by the State of New York, Albany.

† Published by New York Academy of Sciences, New York.

Bibliography of Scientific Publications relating to the Province of New Brunswick other than those contained in the Bulletins of the Society, 1890–1895.

By Samuel W. Kain.

It is proposed to publish each year in the Bulletin the titles of all works other than those contained in the Bulletins themselves relating to New Brunswick, in the subjects coming within the scope of the Society's work.

General works, merely with occasional references to New Brunswick, will not be included, but only such as relate specifically to the natural history of New Brunswick, or contain chapters or sections devoted specifically to it, or which contain results of studies carried on in New Brunswick or upon materials obtained in the province.

The multiplication of scientific publications makes it impossible for any, except specialists, and difficult for them, to keep track of scientific literature; hence for those interested in a more general way, as well as for the use of coming students, it is desirable to have placed permanently on record all obtainable titles.

It has been thought advisable to begin with the year 1890 and bring it up to present date, but in future to give only those of the year with any omissions from previous lists. Members and correspondents are earnestly requested to aid in making these lists complete.

GEOLOGY.

Bailey, L. W.—The Gold-bearing Rocks of New Brunswick, and the Possible Discovery of Remunerative Gold Deposits. *Trans Royal Society of Canada, Vol. IX, sec. iv, pp.* 21–27. 1891.

On the Mineral Resources of New Brunswick. *Canadian Mining and Mechanical Review.* 1891.

Chalmers, Robert.—Report on the Surface Geology of Eastern New Brunswick, North-western Nova Scotia, and a portion of Prince Edward Island. (In press).

Annual Report. Geological Survey of Canada, Vol. VII, (N. S.), Part M., pp. 149. With three maps. 1895.

ELLS, R. W.—The Geology of the Proposed Tunnel under the Northumberland Strait. *Trans. Royal Society of Canada, Vol. XI, Sec. IV, pp.* 75–81. 1893.

GOODWIN, W. L.—Reclaiming Bog in Westmorland County, N. B. *Can. Record of Science, V– p.* 364. 1893.

MATTHEW, GEO. F.— On Cambrian Organisms in Acadia. *Trans. Royal Society of Canada. VII, Sec.* 4, *pp.* 135–163, 5 plates, 3 cuts. 1890.

On Some Causes which have Influenced the Spread of the Cambrian Faunas. *Canadian Record of Science, Vol. IV, pp.* 255–269. *Jan.* 1891.

Illustrations of the Fauna of the St. John Group. *No. V. Trans. Royal Society of Canada. VIII, Sec.* 4, *pp.* 123–169. 6 plates, 3 cuts. 1891.

On a New Horizon in the St. John Group. *Canadian Record of Science, Vol. IV, pp.* 339–343. *Oct.* 1891.

Notes on Cambrian Faunas. I, The Taconic Fauna of Emmons compared with the Cambrian Horizons of the St. John Group. *American Geologist, Nov.* 1891, *pp.* 287–291.

Note on Leptoplastus. *Canadian Record of Science, pp.* 461–462. *Dec.* 1891.

Illustrations of the Fauna of the St. John Group, *No. VI. Trans. Royal Society of Canada. Vol. IX, Sec.* 4, *pp.* 33–65. 2 plates. 1892.

Trematobolus, an Articulate Brachiopod of the Inarticulate Order. *Canadian Record of Science, pp.* 276–279. *January,* 1893.

On the Diffusion and Sequence of Cambrian Faunas. *Trans. Royal Society of Canada. Vol. X, Sec.* 4, *pp.* 3–16. 2 cuts. 1893.

Illustrations of the Fauna of the St. John Group. *No. VII. Ibid., pp.* 95–109. 1 plate. 1893.

Illustrations of the Fauna of the St. John Group. *No. VIII. Ibid., Vol. XI, Sec.* 4, *pp.* 85–129, 2 plates, 1 cut. 1894.

Post-Glacial Faults at St. John, N. B. *American Journal of Science, XLVIII, pp.* 501–503. *Dec.* 1894. 1 *plate.*

On the Organic Remains of the Little River Group. *Nos.* 2 and 3. *Trans. Royal Society of Canada. Vol. XII, Sec.* 4, *pp.* 89–112. 1 plate. 1895.

The Protolenus Fauna. *Trans. New York Academy of Sciences. Vol. XIV, pp.* 101–153. 11 plates. 1895.

MATTHEW, WM. D.—On Phosphate Nodules from the Cambrian of Southern New Brunswick. *Trans. New York Academy of Sciences. Vol. XII, p.* 108. 1893.

The Intrusive Rocks near St. John, New Brunswick. *Trans. New York Academy of Sciences. Vol. XIII, p.* 185, *pl. V.* 1894.

The Effusive and Dyke Rocks near St. John, N. B. *Trans. New York Academy of Sciences. Vol. XIV, p.* 187, *pl. XII–XVII.* 1895.

PHYSIOGRAPHY.

BAILEY, J. W.—The Saint John River in Maine, Quebec, and New Brunswick. Cambridge, Mass. 1894. 178 *pp. Map.* (An excellent popular work).

EATON, FRANK H.—The Bay of Fundy Tides and Marshes. *Popular Science Monthly, Vol. XLIII. No. 2, pp.* 250–256. *June* 1893.

KOBBÉ, GUSTAV.—The Tides of the Bay of Fundy. *Scribner's Mag. XIV, p.* 335–343. 1893.

MURDOCH, WM.—Why Ice in the Kennebeccasis Expands in a North-westerly Direction. *St. John Globe. March* 10, 1894.

RECLUS, ELISEÉ.—Physical Features, etc., of New Brunswick. *The Universal Geography, Vol. XV, pp.* 339–367, 1893. (?)

BOTANY.

GANONG, W. F.—On Raised Peat-bogs in New Brunswick. *Botanical Gazette, XVI, pp.* 123–126, *May* 1891.

HAY, GEO. U.—The Flora of New Brunswick. *Trans Royal Society of Canada, XI, Sec.* 4., *pp.* 45–50. 1893.

Native Trees and Shrubs. *Educational Review, April* 1891.

PERKINS, H. F.—The Flora of Blissville. *St. John Gazette, March* 8th, 1894.

Preliminary List of Plants found growing on Grand Manan. *St. Croix Courier. Jan.* 31, 1895.

ZOOLOGY.

ALLEN, J. A.—Notes on Mammals from New Brunswick, with description of a New Species of Evotomys. *Bull. Am. Mus. Nat. Hist. VI, pp.* 99–106. 1894.

On the Seasonal Change of Color in the Varying Hare *(Lepus Americanus) Ibid., pp.* 107–128.

Remarks on a Second Collection of Mammals from New Brunswick. *Ibid., pp.* 359–362.

BAILEY, PROF. L. W.—A New Snake Find. (Note on *Storeria occipito-maculata.*) *Educational Review, Dec.*, 1890.

FEWKES, J. WALTER.—On Excavations made in Rocks by Sea-urchins. *American Naturalist, XXIV. pp.* 1–21. 1890.

A Zoological Reconnoissance in Grand Manan. *Ibid., XXIV, pp.* 423–435. 1890.

GANONG, W. F.—Southern Invertebrates on the Shores of Acadia. *Trans. Royal Society of Canada, Vol. VIII, Sec. IV, pp.* 167–185. 1890.

MILLER, G. S.—Description of a New Jumping Mouse from Nova Scotia and New Brunswick, *Am. Naturalist, XXIII, pp.* 742–743. *Aug.*, 1891.

Description of a new White-footed Mouse from the Eastern United States. *Proc. Biological Society of Washington, VIII. pp.* 55–70. 1893. (The mouse also from N. B.)

PRINCE, E. E.—A Morning among Moose. *Ottawa Naturalist, Vol. XI, No.* 5, *pp.* 103–107. 1895.

ETHNOLOGY.

ADNEY, TAPPAN.—Milicete Natural History. *Proc. Lin. Soc., New York, No.* 5, *pp.* 19–38. 1893. (Maliseet names of the common birds and mammals, with comments).

FEWKES, J. WALTER—The Use of the Phonograph in the Study of the Languages of the American Indians. *American Naturalist, XXIV, pp.* 495–476, 1890.

Contributions to Passamaquoddy Folk-Lore. *American Journal Folk-Lore, pp.* 24, *plate. Dec.* 1890.

GOODWIN, W. L.—Notes on an old Indian Encampment. *Can. Record of Science, Jan,* 1893.

JACK, EDWARD.—The Abenakis of Saint John River. *Trans. Canadian Institute, Vol. III,* 1891–2, *pp.* 195–205, *Toronto.* 1893.

Maliseet Legends. *Journal American Folk-Lore, VIII. pp.* 193–208. *Sept.* 1895.

THE TIDE GAUGE AT ST. JOHN, N. B.

In 1892 the Dominion Government erected a tide gauge at St. John. Gauges have also been erected at St. Paul Island, Belleisle, Father Point, South-west Point (Anticosti) and Halifax.

The gauge column at St. John is situated in the south-east corner of the Reed's Point Wharf (latitude N. 45° 17′, longitude W. 66° 4′). The timber shaft contains two tubes, one of which is used for the eye observation gauge, and the other for the Sir Wm. Thompson self-recording gauge.

It is proposed to operate this gauge for nineteen years (a lunar cycle). A bench-mark has been cut on the south-east corner of the Custom House. The clock plate of the self-recording gauge is 36·95 feet above zero on the eye observation gauge, and 23·03 feet below the bench-mark on the Custom House.

The establishment of the St. John gauge is of interest to geologists, as observations for a series of years would provide data for detection of earth movements.—S. W. K.

NOTE.—For further information see Proceedings Royal Society of Canada, Vol. VIII, pp viii-ix, 1890; Vol. X, pp. ix-x, 1892. Reports of Marine Department 1891, 1892, and 1893.

THIRTY-THIRD ANNUAL REPORT

OF THE

COUNCIL OF THE NATURAL HISTORY SOCIETY

OF NEW BRUNSWICK.

The Council of the Natural History Society desires to lay before the members its annual report on the work for the year now ending:

MEMBERSHIP.

The following additions have been made to the roll of members:

Honorary (Monsig'r J. C. K. Laflamme),	1
Life (Prof. William F. Ganong),	1
Corresponding,	3
Ordinary,	9
Associate,	14
Total,	28

During the year, three of our members have been removed by death.

Geo. F. Smith, Esq., died March 6th, 1894. He was a member for many years, and by his death the Society lost a valued member.

Gilbert Murdoch, C. E., died May 28th, 1894. He was one of the founders of the Society, and in former years contributed some valuable papers. His paper on Meteorology, embracing observations at St. John from 1850 to 1862, was published in 1863, and is a most valuable record.

Mr. H. W. Northrup died June 18th, 1894. He had only been a member for a short time, but was much interested in our work.

FINANCE.

The Treasurer's report shows the following receipts and expenditures:

Balance from last year,	$ 14 79
Dues collected,	107 00
Bulletins sold,	4 05
Government Grant,	125 00
Interest on Investment,	144 00
Other items,	45 50
	$440 34
Current Expenses,	388 03
Balance,	$52 31

LECTURES AND ESSAYS.

During the year, twelve meetings of the Society were held, at which the following papers were read:

1894.

Feb. 6. Fish Life in the Upper Waters of the River St. John. By Wm. M. McLean, M. A.

The Ingratitude of Societies. By Samuel W. Kain.

Mar. 6. (1) Report on the North-westerly Expansion of Ice in the River Kennebeccasis. By Wm. Murdoch, Esq., C. E. (Published in *Globe*, March 10th, 1894.

(2) Dr. Silas T. Rand, Missionary, Linguist, and Author. By Miss Eleanor Robinson.

(3) Botany of the Parish of Blissville, Sunbury County, N. B. By Henry F. Perkins. (Published in *Gazette*, March 8th, 1894.

(4) The Intellectual Pre-eminence of the Germans. By William F. Ganong. (Published in *Educational Review*, March 1894.

April 3. (1) Spring Birds at Petitcodiac—with table showing date of arrivals and departures for five years. By John Brittain.

(2) Bacteria. By W. F. Best.

April 10. A New Re-agent in Blowpipe Analysis. By Prof. W. W. Andrews.

May 1. An Outline of Phytobiology (1st Paper) By W. F. Ganong. (Published in Bulletin XII.)

June 5. (1) Report of Delegate to Royal Society of Canada. By Geo. U. Hay.

(2) Address on the Work of the Experimental Farms. By John Craig, Esq.

(3) The Crystalline Rocks around St. John. By W. D. Matthew. (Published in Bulletin XII.)

(4) Notes on the Botany of the Valley of the Upper St. John. By Merritt Lyndon Fernald. (Read by title.)

Oct. 2. The Mosses of New Brunswick, with a Description of some New Species. By John Moser.

Oct. 9. Some Evidences of a Glacial Epoch. By Charles R. Fisher, Esq. (Published in Bulletin XII).

Nov. 6. Post-Glacial Faulting at St. John. By Dr. Geo. F. Matthew. (Published in Bulletin XII.)

Nov. 13. Outlets of the St. John River. By Dr. Geo. F. Matthew. (Published in Bulletin XII.)

Dec. 4. Recent Plant-studies and Discoveries in New Brunswick. By Geo. U. Hay, M. A.

1895.

Jan. 2. The Mountain Systems of America—A Comparative Study. By Dr. L. W. Bailey. (Synopsis published in Bulletin XII.)

As in former years, a course of elementary lectures in science has been given. It proved of great interest, and was as follows:

PALÆONTOLOGY.

Lecturer, Geo. F. Matthew, D.Sc., F.R.S.C.

Jan. 9. Scope and Purpose of the Science.

23. Trilobites of the St. John rocks.

30. Fossil Botany of the Palæozoic Rocks, with special reference to the coal measures and plant bearing beds at St. John.

BACTERIA.

Lecturer, W. F. Best, Esq.

Feb. 13. Historical Sketch of Subject, etc.

20. Fermentation and Yeasts.

27. Bacteria of the Mouth, etc.

BIRDS.

Lecturer, Philip Cox, B.Sc. Ph.D.

Mar. 13. Organization of Birds in Relation to their Habits.
20. Plan of Birds in the Economy of Nature.
27. Intelligence of Birds, inherited and acquired.

PLANTS.

Lecturer, Geo. U. Hay, M.A., F.R.S.C.

April 10. The Plant as a Living Being, etc.
17. Flowerless Plants, Structure, Classification, Uses.
24. Flowering Plants, Structure, Mode of Reproduction. From seed to fruit. Classification.

LIBRARY.

The year has seen large accessions to the library. Among donations specially worthy of mention are seven volumes of the *Educational Review*, from Mr. Geo. U. Hay, and a large number of zoological works from Prof. W. F. Ganong.

Prof. Ganong has also generously presented to the Society 200 copies of his work on the Economic Mollusca of Acadia, bound in cloth.

A valuable set of works on Palæontology has been acquired by purchase.

BOTANY.

This delightful study has been brought before the Society very prominently during the year. Six papers have been read on this subject, and in the elementary course three lectures have been given. A number of plants new to the province have been discovered, and a complete list of our mosses has been prepared by that veteran student, Mr. John Moser. Messrs. Hay and Ganong have undertaken a new text-book in botany suitable for these Atlantic Provinces, and it is confidently expected that the proposed work will do much to increase the widening popularity of this science.

MUSEUM.

The Custodian has continued mounting the European plants and doing other museum work. The rooms received a thorough cleaning, and the collections are all in fair condition.

The Room Committee have had the entrance and halls thoroughly cleaned and painted. The mammals have been removed from the Lecture Hall to the room up-stairs, formerly used as a laboratory. It is considered that this change will be an improvement.

The rooms have been open as usual, and a large number of visitors have examined the collections.

PUBLICATIONS.

Bulletin XII will be issued shortly and sent to members. It will be found a number of unusual interest. A number of papers have been published in the daily press.

The Council regret that limited means makes it impossible to publish a larger Bulletin.

GEOLOGY.

The Geological Committee report some additions to the museum. Special reference is made to a fine collection of fossils from the drift of Bedfordshire, Great Britain, presented by Charles R. Fisher.

Geological work in the vicinity of St. John has been prosecuted by members of the Society, and by visitors from various colleges and technical schools in the United States. Among the former, one of our corresponding members, W. D. Matthew, has during the past summer been pursuing his studies on the volcanic rocks around St. John.

Among the visitors who were here in the past year were professors from Columbia College, Yale College, and the Institute of Technology, Boston.

GENERAL.

During the year no summer camp was held, but many members spent some time afield. Our president made a hasty visit to the Devonian deposits at Lepreau Basin, with a view of holding a summer camp there next season. Vice-president Hay made an excursion to the Upper St. John. Dr. Cox has been working hard at his special work, and Mr. F. G. Berton and the Secretary made a survey of the sea-shore plants in the vicinity of St. John.

We record with pleasure our hearty appreciation of the support given to this Society by the ladies. In almost every department of human activity women are showing that they are capable of taking an advanced place. In England Miss Raisin and Miss Crane, and in the United States Miss Rosa Englemann have done scientific work of great merit, and won a recognized place in the world of science. And it is a matter for congratulation that we have in our midst some ladies who have done good local work in natural science.

The Society gave a conversazione to the members of the New Brunswick Educational Institute, which met last June in this city. About 500 were present, and a very pleasant evening

was spent. The Society has continued to co-operate with the University Extension movement, and two courses will be given in our rooms this winter. Our president gives four lectures on Invertebrates, and will be followed by Dr. Cox with four on Vertebrates.

The Council wish to thank the press of St. John for the free insertion of preliminary notices of meetings, and they also thank all who have prepared papers for the Society.

One-third of a century has passed away since the foundation of this Society. Many of those who were active in carrying on the work in years gone by are no longer here, but their work remains.

The collections have assumed valuable proportions. In geology, mineralogy, archæology, botany, molluscs, fishes and birds, we have excellent collections that would be valued by any museum in Canada, and we look forward to the day when public liberality or private munificence will provide for them a fit and proper home.

These collections are not ours—they belong to the people of New Brunswick, and we hope that an enlightened public spirit will see that such a valuable heritage be preserved for generations to come.

Respectfully submitted,

SAMUEL W. KAIN,
Secretary to Council.

NATURAL HISTORY ROOMS, MARKET BUILDING,
St. John, N. B., January 15th, 1895.

DONATIONS TO THE LIBRARY, 1894.

Donor's Name.	Residence.	Work.
Royal Society	London	Proceedings.
Geological Society	do	Abstract Proceedings
Director Royal Gardens	Kew	Bulletins.
Manchester Geological Society	Manchester	Transactions
Biological Society	Liverpool	Proceedings and Tran
Marine Biological Association	Plymouth	Journal.
Belfast Naturalists' Field Club	Belfast	An. Report and Proc.
Royal Society of Canada	Ottawa	Proceedings and Tran
Ottawa Field Naturalists' Club	do	Ottawa Naturalist.
Director Experimental Farms	do	Report.
Department Inland Revenue	do	Bulletins.
Canadian Institute	Toronto	Transactions
Entomological Society of Ontario	London, Ont	Can. Entomologist
Natural History Society	Montreal	Can. Record of Science
Historical and Scientific Society of Manitoba,	Winnipeg	Transactions and Rep
Natural History Society of British Columbia	Victoria, B. C	Bulletin.
Nova Institute of Natural Sciences	Halifax, N. S.	Proceedings.
New Brunswick Historical Society	St. John, N. B.	Collections, Vol. I.
The Author (Geo. U. Hay, M.A., F.R.S.C.)	do	Flora of N. Brunswick
The Author (Geo F. Matthew.)	do	Illus. of the Fauna of the St. John Group.
Geo. U. Hay	do	Educ. Review, 7 vols.
E. A. Charters	Sussex, N. B.	Pamphlets.
William F. Ganong	(Northampton, Mass.)	56 vols. and pamphlets, mostly treating of marine zoology.
The Government of Ontario	Toronto,	Forestry Rep., 1886-91
Toronto Public Library	do	Report.
University of Toronto	do	Pamphlet
Geological Survey of New South Wales	Sidney, N S.W.	Reports.
Australian Museum	do	Catalogue of Birds.
Australian Assoc. for Adv. of Science	do	Report of 4th Meeting
Linnean Society of N. S. W.	Elizabeth Bay,	Proceedings 1883 94.
Government Geologist.	Perth, W. Aus	Reports.
New Zealand Institute	Wellington, N.Z	Proc. and Trans. Vol. 26
U. S. Geological Survey	Washington,	Reports, Bulletins and Monographs.
Bureau of Ethnology	do	Reports and Bulletins
U. S. Fish Commission	do	Reports and Bulletins
U. S. National Museum	do	Report and Proceed's
Smithsonian Institution	do	Report.
U. S. Dept. of Agriculture	do	Reports, 1888 to 1892.
U. S. Dept. of Agriculture (Botanical Division)	do	Bulletins and Contributions from U. S. National Herbarium
U. S. Coast and Geodetic Survey	do	Report.
International Geological Congress	do	Proceedings, 1893.
University of California	Berkley, Cal.	Bulletins & Pamphlets
University of Michigan	Ann Arbor	Reports & Pamphlets.
Cornell University	Ithaca, N. Y.	Bulletins.
Tufts' College	Tufts Col., Mass	Studies.
Johns Hopkins University	Baltimore, Md.	Circulars.
Amherst College		Calendar.
Boston Society of Natural History	Boston	Proceedings.
Marine Biological Laboratory	do	Annual Report.
Boston Public Library	do	do.
Essex Institute	Salem	Bulletins

Donations to the Library — (*Continued.*)

Donor's Name.	Residence.	Work.
New York Microscopical Society	New York	Journal.
New York Academy of Sciences	do	Transactions.
American Museum of Natural History	do	Report and Bulletin.
Linnean Society of New York	do	Abstract of Proceed.
Nat. Science Assoc. of Staten Island	New Brighton	Proceedings, 4 vols.
Rochester Academy of Sciences	Rochester, N. Y.	Proceedings.
New York State Museum	Albany, N. Y.	45th and 46th Annual Report.
Iowa Academy of Sciences	DesMoines, Ia.	Proceedings, 1893.
Tacoma Academy of Sciences	Tacoma, Wash.	Proceedings.
Academy of Natural Sciences	Philadelphia	do
Prof. E. D. Cope	do	Several Pamphlets.
Colorado Scientific Society	Denver, Col.	Proceedings.
Cincinnati Society of Natural History	Cincinnati, O	Journal, Vol. XVII.
Public Museum	Milwaukee, Wis	Eleventh Annual Rep
Missouri Botanical Garden	St. Louis, Mo.	Annual Report, 1894.
National Museum of Costa Rica	San Jose	Report.
Museu National	Rio de Janeiro	Archivos, Vol. VIII.
Societe Scientifique du Chile	Santiago	Actes, 1894.
Adrien Dollfus	Paris	Feuille des Jeunes Naturalistes.
Societe Royale Malacologique de Belgique	Brussels	Proceedings.
Vereins fur Erdkund	Leipsic	Mitteilungen, 1894
K. K. Naturhistorischen Hofmuseum	Vienna	Annalen, 1893.
Comite Geologique du Russie	St. Peters'g	Memoirs & Bulletins.
Imperial Academy of Sciences	do	Bulletins.
Royal Swedish Academy of Sciences	Stockholm	Proceed. and Bulletins
Royal University of Norway	Christian a	Description of Norwegian Rocks by Dr. Kjerulf.

Purchased.

Reports of Geological Survey of Illinois, Vols. I-VIII
Report U. S. Geological Survey of the Territories, Vol. III, Book I
Geology of Iowa, Vol. I, Parts 1 and 2.
Text-Book of British Fungi, by Wm. Delisle Hay.
Maury's Physical Geography.

Note.— *The Library is open every Tuesday evening.*

DONATIONS TO THE MUSEUM.

Date.	Donor's Name and Description of Article.
1894.	
Feb.	Frank E. Holman Esq.—Albatross, mounted, in glass case.
	Geoffrey Stead, Esq., C.E.– Indian relics from Grand Cane, La., U. S. A. Arrow Heads of Stone mounted on four cards. Ring-necked snake, Portland, N. B.
Mar.	Vanwart Bros., St John, N. B., Cryptocanthodes maculatus (the wry-mouth), St. John Harbor.
Apr.	Miss Bessie Matthew, St. John, N. B., Spanish Moss from Florence, S. C.
Oct.	Mrs. Wm. Bowden, St. John, N. B., Stone Arrow Head, Sandy Point, St. John County.
	Mrs. Mary Lawrence, St. John, N. B., Caribou, mounted.
Nov.	Wm. M. McLean, Esq., St. John, N. B., Sea Turtle, Bay of Fundy.
Dec.	Dr. H. M. Ami, Ottawa, Ontario, Post Pliocene Fossil Fish, (Capelin) Green's Creek, Ottawa River.

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